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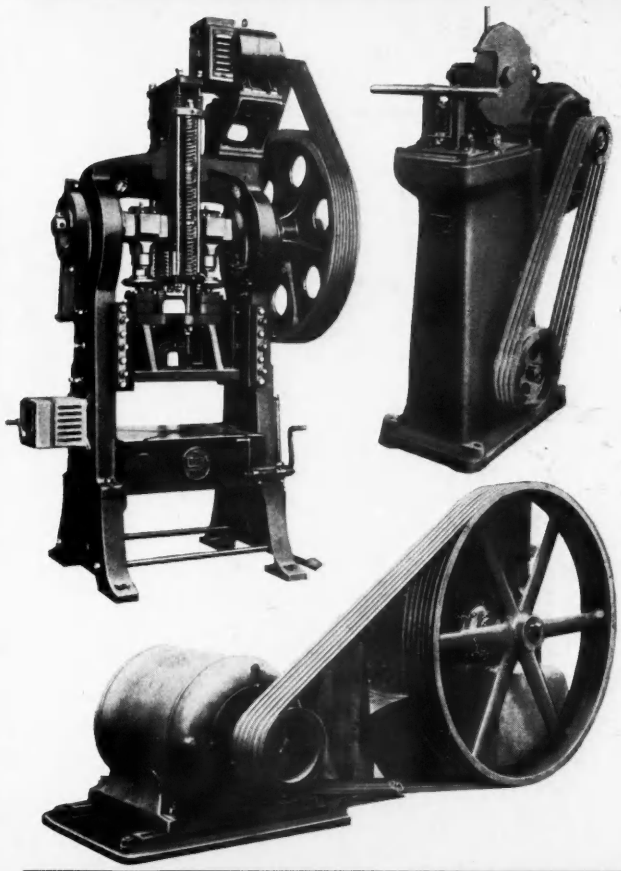

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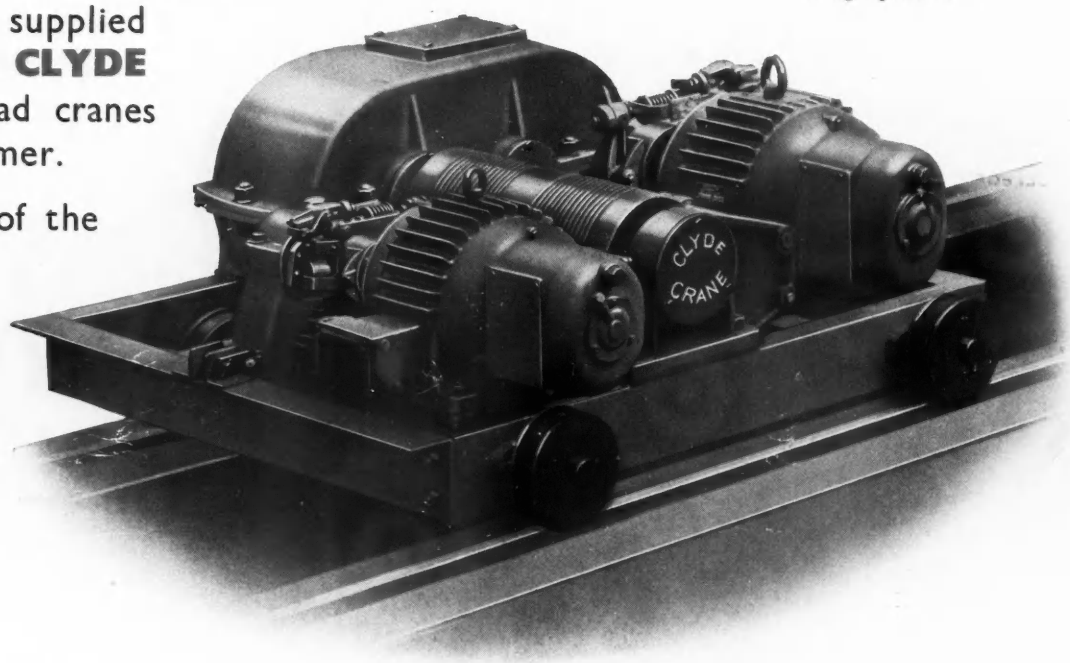

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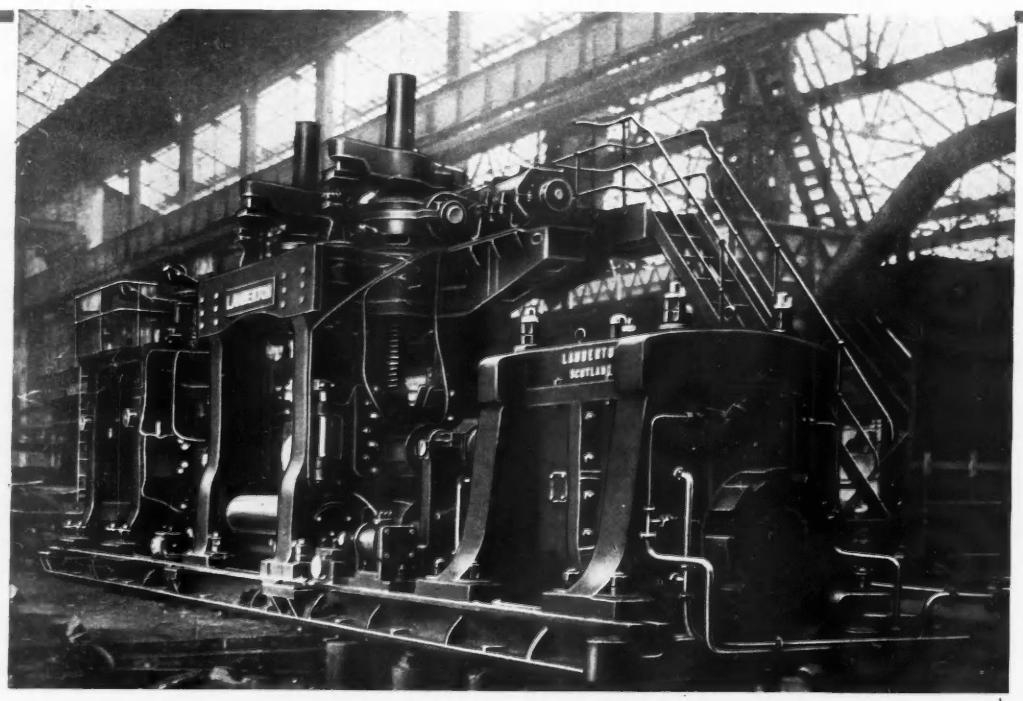

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Statement on Iron and Steel Scrap

In a statement made last week on the procedure for handling iron and steel scrap, Mr. Herbert Morrison, the Minister of Supply, said that he was satisfied that the steel works are to-day receiving all their requirements of home-collected iron and steel scrap, and that it was his intention to ensure the continuance of this state of affairs, even if the works demand were to increase and conditions become more difficult. The presence in municipal yards, village dumps and other dumps of scrap did not mean, as was sometimes supposed, that scrap was neglected or unwanted. These dumps were in effect scrap reserves. Inquiries he had made satisfied him that there was at present no hold-up caused by the arrangement whereby the steel works purchased scrap only from the members of the Scrap Merchants' Federation. The merchants were employed because of their ability to deal with the many technical questions which arise in the handling and disposal of iron and steel scrap metal. The opinion he had formed, Mr. Morrison said, was that the difficulties which might arise and cause possible obstruction later on in the free flow of scrap to the steel works were not primarily difficulties of a commercial kind at all, but were questions mainly of labour and transport. Both these matters were receiving close attention. He hoped that very shortly it would be possible to arrange for an additional supply of labour for the sorting, breaking and transport to the steel works of the scrap collected. Returns recently made went to show that the steel works were taking 50 per cent. more scrap than they were at the beginning of the war, and that the stocks in the merchants' yards were actually lower than they were at that time. New plans for securing supplies of special forms of scrap on a large scale were needed. A scheme for securing disused tram rails was already in operation, and arrangements were being made by the Ministry of Supply for a comprehensive survey of all heavy scrap in the form of railings, derelict factories, pitheads and other obsolete structures.

Road Transport in War-Time

The Minister of Transport, Sir John Reith, has informed Mr. Sidney E. Garcke, the Chairman of the Roads Goods Transport Emergency Committee, that he has given full and careful consideration to the Report of the Committee dated May 30th, but that he does not feel it possible to accept the Committee's main proposals. It may be recalled that the Committee was requested by the former Minister, Captain Wallace, to report on the operational and financial management of goods vehicles, which may be transferred, either by requisitioning or voluntarily, in times of special emergency from their normal base to another. In the Committee's Report, which was published on Saturday last, the Committee states that one of its fundamental conclusions is that a comprehensive scheme to provide for the operation of transferred vehicles is essential in the interests of economy and efficiency. The Report urges that road transport should become part of a properly co-ordinated scheme embracing all four forms of internal transport. The Committee proposes that an emergency Road Haulage Board should be set up. It also urges that the powers to requisition vehicles should be used only as a last resort, and that the comprehensive scheme suggested should be equally capable of dealing with both requisitioned and voluntarily provided vehicles. In his letter to Mr. Garcke the Minister states that the uncertainty as to the magnitude and the location of transport difficulties due to enemy action affords strong arguments in favour of the existing decentralised organisation. Even in the event of a major general dislocation of transport it seems that, to put into operation at short notice in an emergency and under conditions which have become considerably more acute since the Committee reported, a scheme involving extensive changes in the machinery for handling road transport would lead to a serious risk of confusion. The Minister also feels that there would be considerable difficulty in setting up a statutory board.

A Southampton Dock Jubilee

Friday, July 26th, marked the fiftieth anniversary of the opening of the Empress Dock at Southampton by Queen Victoria. The appropriate celebration of this occasion, which was the beginning of the modern port of Southampton, has been unavoidably prevented by the carrying on of essential war work, but the event is one calling for some mention in these columns. It was in 1886 that Parliament permitted the London and South-Western Railway Company to lend to the Southampton Dock Company the sum of £250,000 for the purpose of building the dock which afterwards came to be known as the Empress Dock. Work was begun in 1886, but during the construction of the dock, trouble was experienced with the erosive effect of the double tide at Southampton, which caused part of the eastern wall of the dock to collapse, delaying the completion of the dock for about a year and increasing its cost. On July 26th, 1890, Queen Victoria, who was then staying at Osborne House, in the Isle of Wight, and was accompanied by the Duke of Edinburgh, the Duke and Duchess of Connaught and Princess Christian, proceeded to Southampton in the "Alberta" and inaugurated and christened the dock. The Empress Dock has a depth of about 26ft. at L.W.O.S.T. and is used by the Royal Mail Steam Packet Company. Prior to the war the dock was the busy scene of the company's South American meat trade, and was also employed for transport work. The present dock has a total quay length of over 3800ft. and has eight berths, which are well equipped with hydraulic cranes.

Machine Tool Prices Controlled

On Tuesday, July 30th, it was announced by the Ministry of Supply that the Control of Machine Tools (No. 2) Order, 1940, dated July 25th, 1940, had been issued by the Minister of Supply under Regulations 55 and 98 of the Defence (General) Regulations, 1939. The Order states that no person in the United Kingdom shall pay or receive for any new machine tool produced in the United Kingdom any price other than a price fixed by the Minister of Supply by Order. It also establishes a price for machine tools produced in the United Kingdom and sold for use in the United Kingdom of a type set out in the schedule to the Order and identical with those on offer for sale during a standard period which is taken as the six months ended December 31st, 1935. It is recommended that intending purchasers of machine tools should make themselves familiar with the terms of the Control of Machine Tools (No. 2) Order, 1940, copies of which can be obtained from H.M. Stationery Office or from any bookseller.

Canada's Aircraft Production

In announcing the appointment of Mr. R. P. Bell, of Halifax, to co-ordinate Canadian aircraft production and increase the output of machines throughout the Dominion, the Hon. C. D. Howe, the Minister of Munitions and Supply for Canada, has given some interesting facts concerning the progress made in the manufacturing and training scheme. He states that the Government will be able to complete both the Canadian programme and the whole general air training programme from the Dominion's own resources, without help from overseas. Work is well advanced on all the orders for aeroplanes required under the joint air training scheme, and arrangements have been made for the purchase elsewhere of some 5000 engines which were to have come from Great Britain. Supplies of instruments and other necessary equipment have also been arranged. Under the air training plan pilots first fly fleet trainers and De Havilland "Tiger Moths" in the elementary training school, and about 800 of these machines are needed. Nearly 200 have already been delivered from Canadian plants—one aircraft works is turning out two a day—and by the end of the year all the training aeroplanes wanted will be delivered. The learner then goes on to larger and faster trainers, which include "Ansons," "Fleet Sixties" and "Harvards." Eight hundred of the last-named type of machine are on order in Canada and the United States, and some of these will be used instead of the Fairey "Battle" aeroplanes which were to have been shipped from England. The production of secondary training types is being so regulated that no pilot who has finished his preliminary flying will be held up for lack of more advanced-training machines. Nine Canadian factories are making component parts for 1509 twin-engined "Ansons," and special measures have been taken to speed up the production of this type, which forms one of the most important units under the air training plan.

Reduced Hours in the Armament Industry

Letters have been sent by Mr. Ernest Bevin, the Minister of Labour and National Service, to the managements of Britain's armament factories, outlining schemes for the rotation and reduction of the number of hours worked in any week. It is aimed by the schemes outlined to reduce the number of hours in the working week to the optimum hours for men which experience in many fields of manufacturing activity has shown to be between fifty-five and fifty-six hours. At present many men in the armament industry are working a seven-day week with a total of from seventy to eighty hours. It is thought that the prolongation of these long hours of working might eventually lead to a reduction in the output of work. The plan which has been prepared proposes to extend the aggregate man-hours by the introduction of new labour, and to create a higher rate of productivity per man-hour by the reduction in the number of working hours. In order to increase the supply of labour it is proposed to introduce a new scheme of training which has been designed to increase the annual flow of trainees from the Government Training Centres, technical schools and private employers from 100,000 to 400,000. Pending the arrival of this new labour it is recommended by the Minister that the number of working hours per week should for an interim period be reduced to an average of sixty, and that wherever practicable relief workers should be called in through the local Labour Supply Committees to take the places of unskilled or semi-skilled workers on rest days. Another suggestion is the introduction of a ten-minute refreshment interval near the middle of the normal working period. In a further Order Mr. Bevin has sought to ease the war strain on women and juvenile workers.

War Office Reorganisation

The Secretary of State for War, Mr. Anthony Eden, announced on Tuesday, July 30th, that he had set up a Standing Committee, under the chairmanship of Sir James Grigg, the Permanent Under-Secretary of State for War, with the following terms of reference: "To consider the present administrative organisation and procedure of the War Office and of the military commands with a view to introducing such changes of organisation and simplifications of procedure as are necessary to give the elasticity which war-time conditions demand." Special attention will be given to the timing of any changes so as to ensure that there shall be no dislocation or interruption of the war effort. The members of the Committee are:—Sir Percy Bates, Bart., the chairman of Cunard White Star, Ltd.; Mr. G. W. Dunkley, of the Irak Petroleum Company, Ltd.; Lieut.-General Sir Robert Haining, Vice-Chief of the Imperial General Staff; Mr. R. J. Sinclair, Director-General of Army Requirements; General Sir Walter Venning, Quartermaster-General to the Forces; and Lieut.-General H. C. B. Wemyss, Adjutant-General to the Forces. It is further announced that the Irak Petroleum Company, Ltd., has placed Mr. Dunkley's whole-time services at the disposal of the War Office in connection with Committee's work. Mr. R. J. Sinclair, who has been seconded to the War Office by the Imperial Tobacco Company, Ltd., has been Director-General of Army Requirements since October last. It is separately announced that His Majesty has been graciously pleased to appoint Mr. Sinclair, who is already a member of the Supply Council, a member of the Army Council. Mr. E. M. Fraser, Director of Investigation and Statistics at the War Office, and Mr. L. A. Munro, Deputy-Director, will assist the Committee. The services of these two gentlemen were placed at the disposal of the Army Council by Imperial Chemical Industries last autumn.

Statement on Non-Ferrous Scrap

On Tuesday, July 30th, the Minister of Supply, Mr. Herbert Morrison, announced the steps which the Ministry will take to ensure that the best use is made of scrap metal, other than iron and steel for which plans have already been announced. The Ministry will guarantee to purchase from smelters at a fixed price rough copper and secondary pig lead reaching certain percentages of purity. With this guaranteed market smelters will be able to purchase from dealers the lower grades of non-ferrous scrap which has been tending to accumulate. The Ministry of Supply points out that there has not been any difficulty or hold-up in the case of high-grade brass or copper scrap which finds its way into consumption at works. The difficulty has affected only lower-grade alloys, and the step now announced should ensure the interest of the smelting works in these alloys, since they can be sure of disposing of the metal after treatment. The terms of the official announcement are as follows: "The Controller of Non-ferrous Metals will, until further notice, be prepared to buy (*a*) rough copper produced from works in this country assaying not less than 97·25 per cent. copper at a price of £53 per ton, f.o.r. sellers' works; (*b*) rough copper assaying 99 per cent. copper or over, produced from works in this country, at a price of £54 per ton, f.o.r. sellers' works, for delivery within three months of the date of each contract; payment net cash when the copper is placed at the disposal of the Non-ferrous Metals Control, together with certified assay showing the copper content. The Controller is also prepared to buy pig lead refined in this country for delivery within three months of the date of each contract, at the price of £22 10s. per ton, f.o.r. sellers' works, provided that the lead content is 99·98 per cent. or over and that the impurities do not exceed the following limits:—Antimony, 0·003; copper, 0·0015; bismuth, 0·01; tin, 0·0001; zinc, 0·0001; iron, 0·0003; arsenic, trace; silver, 5 dwt. Payment net cash when the lead is placed at the disposal of the Non-ferrous Metals Control, together with certified analysis. Inquiries should be addressed to the Controller, Non-ferrous Metals Control, Grand Hotel, Rugby.

Automatic Train Control

No. IV

(*Continued from page 54, July 26th*)

IN coming to consider the development and the present position of A.T.C. in the U.S.A., one is apt to compare what has been done in that country to the more gradual progress elsewhere, without relating technical achievement to the background of railway and transport conditions generally in the respective countries. Although in this country a short series of disastrous accidents during the first decade of the twentieth century revealed a need for something more than ordinary block working, matters were left entirely to the engineers of individual railway companies, to

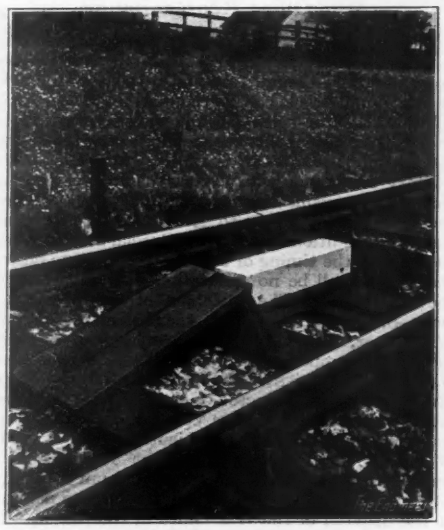


FIG. 24—INDUCTOR ON L.M.S. RAILWAY

the manufacturers of signalling apparatus, and most of all to free-lance inventors. With no recurrence of the wave of misfortune that occurred during 1906, very little real progress was made, except, of course, on the London Underground railways, which always need to be considered in a class apart. Even to-day, when the whole field of A.T.C. development has been considered in great detail by successive committees appointed by the Ministry of Transport, no fixed recommendations, let alone definite instructions, have been issued to the railway companies on this matter.

In America, on the other hand, public feeling towards the accident record was such that many of the leading railway companies were ordered by the State to equip specified sections of their lines with A.T.C. And in contrast to the somewhat leisurely development to be seen in this country the leading American manufacturers of signalling material had to work at top speed to comply with the numerous orders for equipment, all of which had to be installed by definite dates fixed by the State orders. Fortunately, however, the manufacturers, and certain of the railways, too, had been fully alive to the ultimate needs in this respect, so that they were in some measure prepared. The wealth of experience gained from these extensive compulsory installations has revealed valuable data regarding A.T.C. generally, and has shown, among other things, that continuous speed control—in many quarters often thought to be the ultimate ideal—has many drawbacks from the practical operating point of view.

The continuous system of train control and cab signalling was developed only after many experiments had been made with intermittent schemes. In this development the Union Switch and Signal Company, in collaboration with engineering and traffic officers of the Pennsylvania and other railways, has played a leading part. This manufacturing company was in the field as early as 1889, and about that time the simple tripping device mentioned in the third article of this series, in connection with the Kofler apparatus, was tested on the Pennsylvania Railroad. From this idea it was a logical development to transfer the trip cock from the roof of the cab to a position near rail level, and in 1900 the Boston Elevated Railroad was equipped with train stops co-acting with automatic block signals in a form of lay-out that has proved to be the forerunner of many similar ones in the U.S.A., and can well claim to be the prototype of the present automatic train-stop system used on the railways of the London Passenger Transport Board.

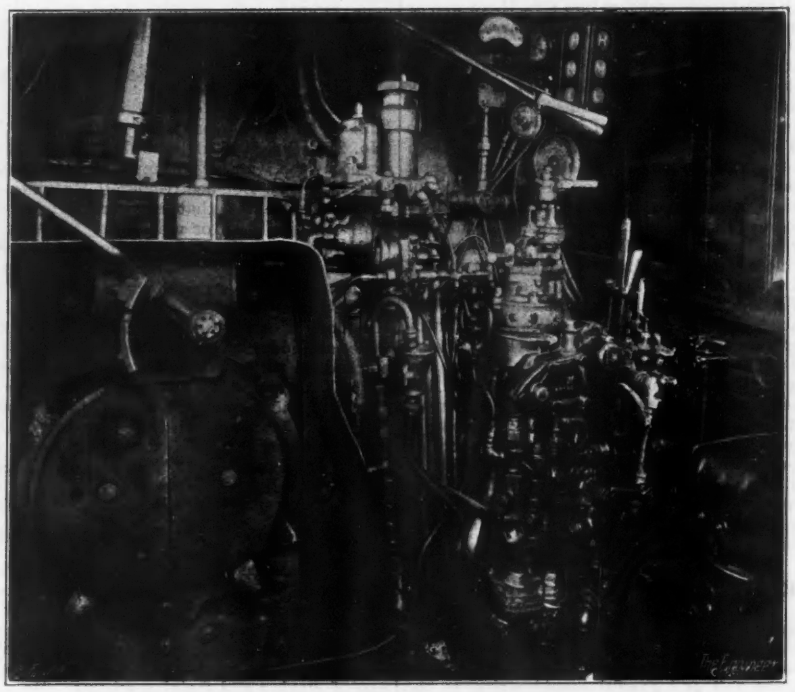


FIG. 26—CAB OF AMERICAN LOCOMOTIVE

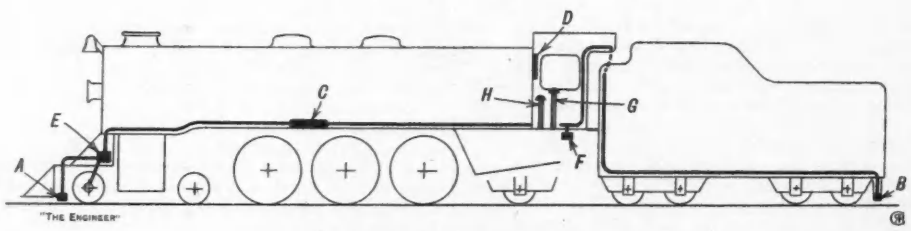


FIG. 25—DIAGRAM OF APPARATUS LAY-OUT

In the early years of the present century the automatic operation of wayside signals had progressed rapidly in America, and railway officers there were beginning to realise that such signals, far from constituting merely an added safeguard and a means of stopping trains, were of great value in keeping trains on the move. The invention and design of A.T.C. equipment naturally developed on the same lines, and from the original installations of automatic train-stops experiments were made in controlling the speed of trains through the agency of contact ramps. In some tests conducted on various railways two ramps were installed a definite distance apart, and when the signal ahead was at danger the time taken to cover the distance between the two ramps was measured; if this time was such as to indicate excessive speed in approaching the stop signal the brakes were applied. In its effect this arrangement was not unlike the distant signal systems now used in this country, but its main importance arose from a very different circumstance, and one hardly likely to occur in Great Britain.

There were unexpected troubles with clearances; cases occurred where the ramps were damaged by vehicles having unusual dimensions, and in others ice packing up against the ramps played havoc with the locomotive collector gear. At the same time as these troubles were being experienced, the view was gradually taken that intermittent train control provided only a partial solution of the problem to be solved. The position was compared to the early days of automatic signalling itself, when the signals were controlled by treadles instead of continuous track circuits. Clearance troubles suggested the desirability of keeping the permanent way absolutely clear of train-control appliances, as was already being done in the case of power mechanisms for point operation; track way appliances fixed like the Hudd inductor shown in Fig. 24 seemed impracticable. And with this in mind the American engineers set themselves the task of devising a system of connection between the wayside signals and the locomotive brake equipment that would keep the speed continuously under control.

Several varieties of the one main system have been evolved, but the principles underlying all these will best be appreciated by consideration of the three-speed train-control apparatus installed on the Santa Fe and other railways. The heart

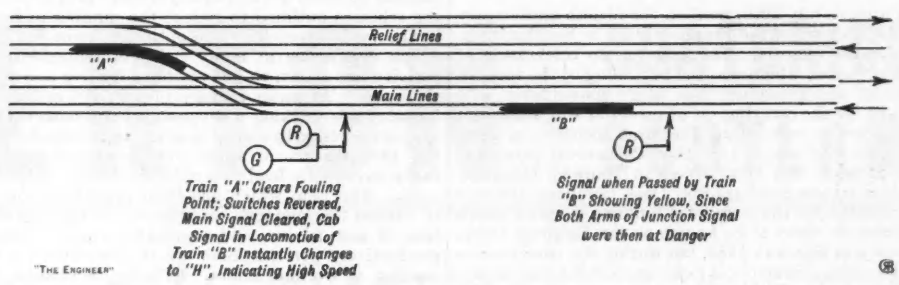

Relief Lines
"A"
Main Lines
"B"
R
G
R
Train "A" Clears Fouling Point; Switches Reversed, Main Signal Cleared, Cab Signal in Locomotive of Train "B" Instantly Changes to "H", Indicating High Speed
Signal when Passed by Train "B" Showing Yellow, Since Both Arms of Junction Signal were then at Danger
"THE ENGINEER"

FIG. 27—INSTANT CLEARING OF CAB SIGNALS

of this system is a two-element alternating current relay, similar in action to those used for switch indication in ordinary power signalling, the revolving disc-type armature of which can take up any one of three positions, closing a different set of contacts in each. The three positions of this relay correspond to high, medium, or low speed. Fig. 25 shows in diagrammatic form the lay-out of equipment on the locomotive. There are two receivers—A, fixed just behind the cow-catcher, picking up current for energising the "local" element of the train control relay, and B, at the rear end of the tender, picking up current for the "control" element. The current in A is induced by the ordinary track circuit current,

FIG. 28—LOCOMOTIVE AND TRACK INDUCTORS

which passes through the leading axle of the locomotive; the induced current in the receiver therefore flows continuously so long as the locomotive is passing through track-circuited territory.

To induce the current in the second receiver B, on which the train-control effects depend, further current is applied to the rails, superimposed upon the track-circuiting current, but flowing down the two rails in parallel and using a return wire independent of the rails. This current is therefore unaffected by the passage of a locomotive, and its nature is controlled by the indications displayed by the wayside signals ahead. The position taken up by the armature of the train-control relay depends upon the phase relationship of the induced current in B to that in A. Both

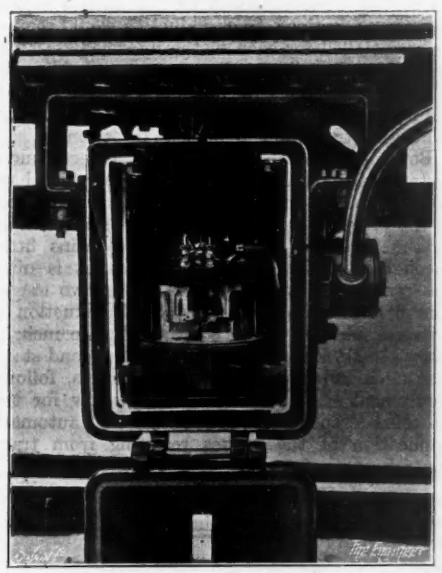


FIG. 29—INTERMITTENT A.T.C. CONTROL RELAY

these induced currents require to be amplified, the necessary equipment, together with other electrical gear, being housed in the case C mounted on the running plate. In the cab is fixed the speed limit indicator D. The interior view in Fig. 26 shows the nature of the indications displayed to the driver, and the side indications showing across the cab for the benefit of the fireman will also be noted. The actual speed is measured by a centrifugal governor E, driven off one of the carrying wheels of the locomotive; this governor is used to open and close certain pneumatic valves, the operation of which, in conjunction with the working of the train-control relay, determines whether or not a brake application shall be made in any particular set of circumstances.

The train-control brake application valve F is quite apart from the ordinary driver's brake valve G; no change from the usual air brake control is made, and provided an engineman observes all the wayside and cab signals and acts in accordance with them, he is left entirely free from interference in the control of the train. It is only when, through misjudgment or carelessness, the signal indications are not obeyed that control is taken out of his hands. Should a man fail to reduce speed in accordance with the cab signals displayed his own brake valve is rendered inoperative until two conditions have been fulfilled—speed must be brought below the new speed limit, the driver's brake valve must be put to the "lap" position. As in the majority of train-control systems so far discussed in this series of articles a device is included, the manipulation of which forestalls the automatic application of the brake. In the particular system now under review it is termed the acknowledging valve, and it is located near the driver's brake valve at H.

Before passing on to a description of the working of this three-speed system under actual traffic conditions, some further features of interest may be mentioned. From the position of the two receivers A and B, it will seem that no current can be induced in A when the locomotive is running tender first, since the track-circuit current is shunted through the rearmost axle of the tender and can never reach the receiver A. In the absence of current from A the train-control relay assumes the low-speed position. In the case of an express passenger or through freight locomotive this would cause little or no inconvenience since tender-first running is exceptional, but with suburban tank engines it is necessary to install duplicate receivers at each end; the change over from one set to the other is then automatically effected through a circuit controller connected to the reversing gear. Another form of change-over equipment comes into operation when a locomotive passes out of train-control territory; then the driver must operate a special cut-out switch, and the cab signal lights are duly put out. On entering a stretch of line on which train control is in force, the locomotive equipment cuts in automatically, no action whatever being required of the driver.

The way in which continuous automatic train control functions can best be appreciated by the description of an imaginary journey of an express passenger train, as experienced on the footplate, in which there occur a number of incidents typical of day-to-day traffic operation. For the purpose of this example British railway working is assumed as being more familiar to readers than the American conditions in which the system is at the moment exclusively used. To avoid for the moment any question of gradients a level road, such as that of the Great Western Railway from London to Taunton, *via* Bristol, is envisaged. The limit for high speed—"H" on the cab signal—is assumed to be 80 m.p.h.; the medium is assumed to be 45 m.p.h., and the low 15 m.p.h.

Train-control territory begins at the terminus itself, and with the road ahead clear the express starts away with the "H" light showing in the cab signal. In about 10 miles speed has risen to 70 m.p.h., and then a wayside signal ahead is sighted at "caution." The driver is fully alert, and as this signal is approached he operates the acknowledging lever to forestall the automatic application of the brake, at the same time operating his own brake valve to comply with the "M" light now displayed in his cab signal. The express has closed in on a slower train, and for two or three block sections it continues running at just under 45 m.p.h., the "M" light being continuously displayed in the cab. Just after passing one of the wayside signals, however, the cab signal changes from "M" to "H"; the train ahead has been crossed over from fast to relief line, and the road is now clear. The driver can therefore begin to accelerate his train back to normal speed before sighting the next wayside signal. The increased flexibility in working to be gained from such an arrangement is valuable at times of heavy occupation of the line; it is illustrated diagrammatically in Fig. 27.

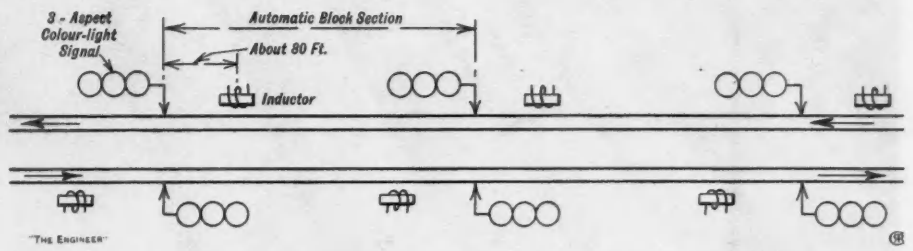


FIG. 30—INTERMITTENT A.T.C. WITH AUTOMATIC BLOCK SIGNALLING

In attempting later on to regain the time lost by this check, the speed limit is inadvertently exceeded by a small amount. The governor duly records this and an automatic application of the brake is made. To obtain release the driver laps his brake valve, and he is then able to continue at a speed inside the limit. On arrival at an intermediate station a number of extra vehicles are added to the train, bringing the load considerably above the maximum tonnage specified for the particular locomotive in use. A pilot engine is therefore attached in front, and as usual its crew take over the responsibility for observing signals and the control of the train. The receivers on this locomotive and tender pick up the train-control current, and connections are arranged between the two locomotives so that the equipment on the second of the two is automatically cut out during the time when the train is being double headed. In continuing this description of the journey the various cab signals and applications

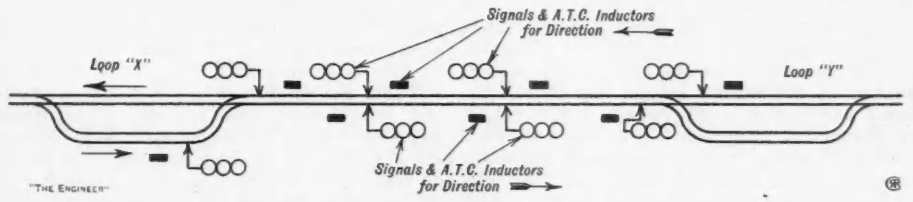


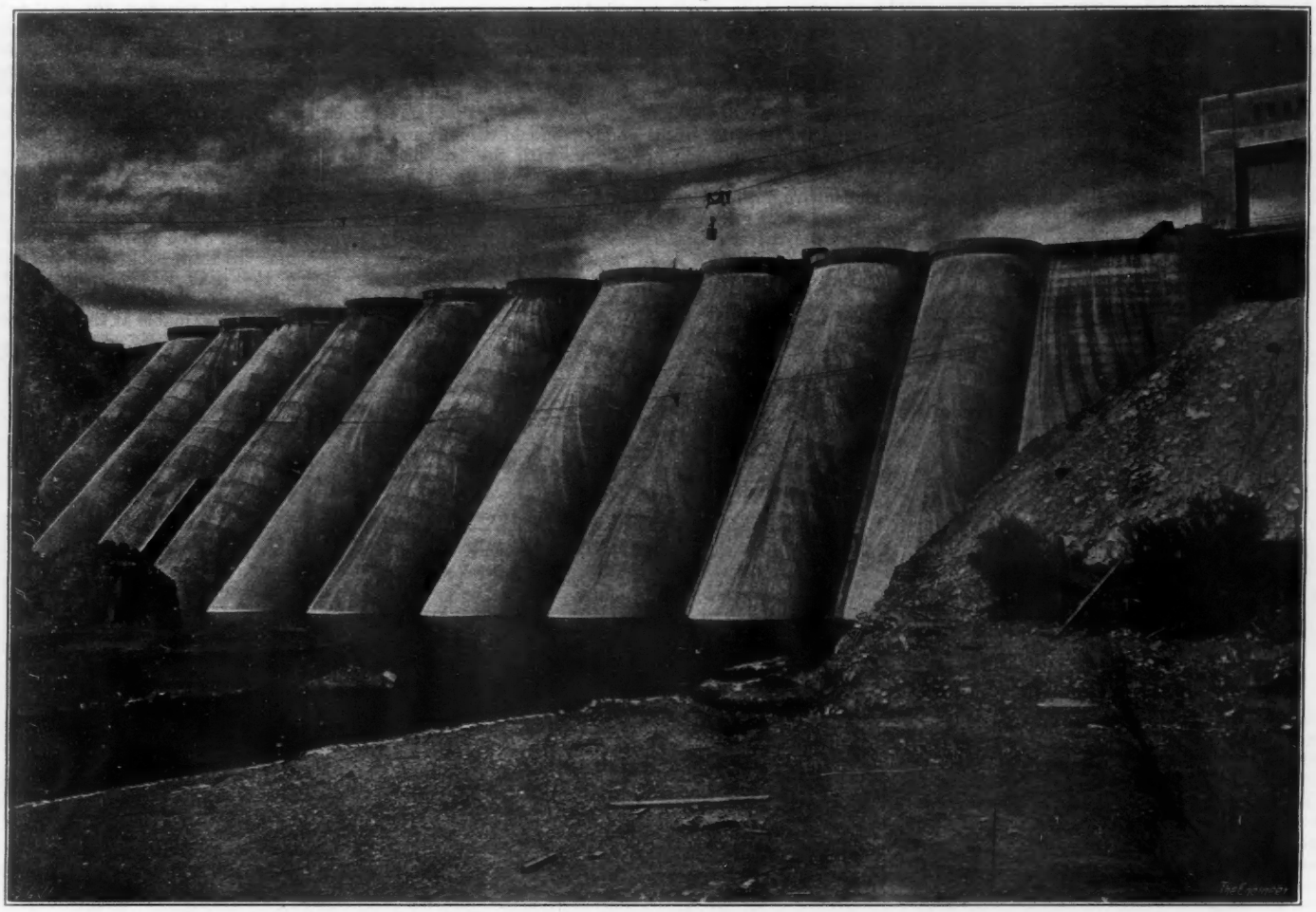
FIG. 31—INTERMITTENT A.T.C. ON ABSOLUTE-PERMISSIVE BLOCK SYSTEM

of train control are thus observed from the footplate of the pilot engine.

For the next 20 miles or so the run continues without incident; then a section of track is approached where relaying is in progress and a speed restriction of 15 m.p.h. is in force during the time work is going on. The track connections of the train-control system have been temporarily changed over, and although the wayside signals are showing the all-clear the cab signal changes to the "M" indication as the warning board is neared. This ensures that a suitable reduction of speed is being made, and it is succeeded by a further change to "L," as the "C" marker, indicating the commencement of the slack, is approached. Such definite control is particularly valuable to drivers on nights of bad visibility, for it is not customary to illuminate the "C" and "T" signs very brightly, and they might easily be missed altogether. Immediately the "T," or termination, sign is passed the cab signal indication changes to "H" once again, and the train is enabled to accelerate to its full speed.

Making up lost time the train is soon running at practically the maximum speed permitted. A mile-long tunnel is neared, and with the signal at the entrance displaying green the train enters

BARTLETT MULTIPLE-ARCH DAM—UPSTREAM VIEW



at high speed, its enginemen justifiably confident of a clear road. Suddenly, however, the cab signal changes from "H" to "L," and an emergency application of the brakes is made; speed is duly brought down to 15 m.p.h., and with the driver of the pilot engine ready to stop the train at a moment's notice they emerge from the tunnel. All this has happened before sighting the next wayside signal, for the tunnel was full of smoke from the passage of a train in the opposite direction and the look-out ahead was a complete blank until coming into the daylight. Then the cause of the sudden warning is revealed; careless shunting at the country station just beyond the tunnel had caused a derailment, and a vehicle was fouling the main line. From the slow speed at which it was travelling the express was easily stopped short of the obstruction. In these particular circumstances intermittent control, based on the distant signal, would have been of no avail and a violent collision would have resulted.

One of the greatest drawbacks to continuous train control is its cost. It can only be applied on lines equipped with continuous track circuiting, and in this country such lines are few and far between. It is necessary, of course, to fix different values of the high, medium, and low speeds to suit the varying classes of traffic. Thus, while passenger trains may be permitted to run up to 80 or even 90 m.p.h., the maximum for a goods train would probably not be allowed to be fixed above 60 m.p.h. In this country, too, still further limits would have to be fixed for loose-coupled, unbraked goods trains; this is a class not found in the U.S.A. In Great Britain, too, there would be added complications arising from the varied duties undertaken by certain well-known locomotive types; the Stanier class "5," 4–6–0s on the L.M.S., for example, may include in a single day's regular working the haulage of an express passenger train running at 80 m.p.h. at times, and later a trip with an unbraked goods. Special apparatus has been designed by which the necessary changes in speed limits can be made, though this, of course, cannot be permitted to be done by the enginemen themselves. To some responsible official at every station where engines are changed would be assigned the duty of seeing that the speed limits were correctly set for the class of work to which each engine was allocated.

An intermittent form of A.T.C. has also been extensively installed in America. Although, in effect, it is very similar to the inductive systems used in Switzerland and in this country, it is interesting in that only one track inductor is used, and also for the simplicity of its details. The track inductor takes the form of a laminated iron core of U shape, around which a winding is placed. The winding is energised only when the signal concerned is at all clear. The locomotive receiver is similar, save that the U is inverted and that the winding is in two parts—a primary and secondary. This receiver is continually magnetised when the locomotive is in service—see Fig. 28. Its windings are so connected that on passing over a track inductor indicating stop the magnetic reaction is such as to generate a counter E.M.F. in this secondary winding; this E.M.F. is large enough to cause the train-control relay to open its contacts and initiate a brake application. The driver can forestall this automatic application by operating a switch. The control relay is usually carried on the tender in the robustly designed shockproof type of mounting shown in Fig. 29.

As a large proportion of the American railway mileage busy enough to warrant the installation of A.T.C. is already equipped with continuous track circuiting and automatic block signalling, the application of this intermittent form of control differs from our own distant signal system. An inductor is installed for every wayside signal, as shown in Fig. 30. This arrangement probably foreshadows what will be done in this country when the time comes for equipping stretches such as that from York to Darlington with the Hudd or other apparatus. An interesting variety of the American intermittent system is that designed for use on single lines. On the western railways there is much single-track mileage, and automatic signalling on what is termed the absolute-permissive block principle is largely used. Referring to Fig. 31 the distance between two passing loops X and Y is so considerable that the section is split up into a number of automatic blocks, and while absolute block working must be used between X and Y for trains travelling in the opposite direction, in the case of a series of trains in the same direction automatic block, as on a double line of railway, can be permitted. To provide intermittent A.T.C. on such a section or series of sections, track inductors would require to be installed for each of the intermediate automatic signals. Since they are mounted in the 6ft. way, as shown in Fig. 28, the receivers on the locomotive would not be affected by inductors relating to traffic in the opposite direction.

Both the intermittent and the continuous systems of A.T.C. as developed in America have been designed to meet every condition experienced in the practical handling of traffic. For example, in the operation of heavy freight trains fitted throughout with continuous brakes, it is often the practice to apply the brakes in two stages. The first stage consists of a small reduction in pressure, about 7 lb. to 8 lb. per square inch, to allow the slack to adjust itself; the second stage, making a full application of the brakes, follows. Equipment has been installed to allow for this so-called "split reduction" in the automatic application of the brakes resulting from train-control action.

(To be continued)

Synthetic Rubber Production in America.—Speaking at a general meeting of the Standard Oil Company of New Jersey, Mr. W. S. Farish, chairman of the company, gave some details in connection with the manufacture of synthetic or "butyl" rubber. The product, he said, could be manufactured in any required quantities as rapidly as the necessary facilities could be installed. A plant for the production of 10,000 lb. a day of the "buna" product from petroleum was under construction at the refinery of the Standard Oil Company of Louisana at Baton Rouge, Iowa, and would be completed before the end of the year. The butyl rubber was produced from petroleum by processes more simple and direct than those required for the buna, and it was more nearly a straight petroleum product. They had already had in operation a semi-commercial butyl plant in Bayway, N.J. The butyl rubber was not oil-resistant, and would therefore not be in direct competition with buna for the speciality markets. The former, however, has special properties of its own which made it superior to natural rubber for many processes. The commercial development of butyl would be made by gradual stages.

BARTLETT MULTIPLE-ARCH DAM—SPILLWAY CHANNEL AND BUTTRESSES

Bartlett Multiple-Arch Dam, U.S.A.

No. I

IN the great variety of types of large dams used in the numerous irrigation, hydro-electric and flood control enterprises in the United States, the multiple-arch type has become conspicuous in recent years by reason of its comparative novelty and its adoption for structures of great height and size. This type of dam has been employed in projects of the Federal Government and also in those of local governmental bodies and private companies. A main consideration in the comparison of dams is the maximum height, as measured from the lowest point of the foundation to the crest. In this respect the record is held by the Bartlett dam, on the Verde River, in Arizona, which reaches a maximum height of 286ft. 6in. This dam, built for an irrigation project of the United States Bureau of Reclamation, and completed in 1939, has a length of only 800ft., including short gravity sections or abutments at the ends. There are ten barrel arches of 48ft. clear span, or 60ft. between centres of the hollow buttresses from which the arches spring. At one end, and beyond the abutment, is a spillway channel 170ft. wide, with regulating gates, but maximum floods in the river will overtop the dam.

A multiple-arch dam is composed of a series of arches or barrel arches, not vertical, but inclined approximately 45 deg., and alternating with buttresses of solid or hollow construction. In this way the inclined upstream face is formed by a series of convex surfaces, and the vertical load due to the weight of water upon this face is a factor in the stability of the dam. In this respect the multiple-arch dam is similar to the hollow type of dam consisting of an inclined face slab of concrete resting against a series of piers. The upstream side of the Bartlett dam is shown opposite, the view being taken before the reservoir had been filled. At the right is one of the gate openings on the spillway, and between the third and fourth arches at the left is the outlet opening. This view shows also the cableway or ropeway used in handling the steel forms and in delivering some of the concrete. In the view of the downstream side, above, the spillway channel is at the left, with its three gates closed. The end of the paved floor of the channel has a raised lip or kerb, with aerating openings below, the purpose being to form a pool or bucket from which the water will leap to the lower part of the channel cut in the rock and not paved. At the right two outlet openings with needle valves are discharging at the rate of about 1500 cubic feet per second.

The Verde River, a tributary of the Salt River, has a drainage area or watershed of 5600 square miles above the dam site, partly mountainous and partly semi-tropical desert, the upper parts reaching elevations of 5000ft. to 8000ft. above sea level. There are heavy snowstorms in the mountains, while the desert area is subject to torrential rains which cause flashy floods. The site selected for the dam is in a canyon which has a width of only about 275ft. at the bottom, and has fairly steep sides in the lower portion. Water from the reservoir formed in the river valley by the dam—with a storage capacity of some 200,000 acre-feet—will supplement the irrigation supply of water for lands in the valley of the Salt River.

Previous to the construction of the dam the maximum flood record on the Verde River was 61,000 cubic feet per second, but in February, 1937, the contractor experienced a flood of 90,000 cubic feet per second, owing to a combination of heavy snow melting in the mountains and a warm rain at lower levels. In March, 1938, another unprecedented flood, 120,000 cubic feet per second, occurred; but this was due almost entirely to rain. No serious damage was done to the unfinished dam, although the arches—completed to a height of 50ft.—were submerged and the buttresses were only 20ft. above water. Much damage was done, however, to the contractor's construction equipment, some of the machinery being washed away and lost, and some of the steel form work being wrecked.

In view of the unusual type and the great height required for this dam, very thorough methods of design and calculation were employed, including model tests and structural analysis. Stress analysis of the arch barrels included elastic deformation due to shear, shortening of the ribs, yielding of the abutments, earthquake shocks and water overflow. Both arch and beam actions were studied. Buttress stresses were calculated for moment, rotations, thrusts and shear forces from the arches, water load, temperature variations—from water cover to air exposure and also earthquake shocks. From all these studies it developed that stresses due to temperature changes would be considerably higher than those caused by water loads. Furthermore, these stresses would be severe since the reservoir will be practically empty for eight to nine months of each year. Unit stresess adopted for the arches included 650 lb. and 750 lb. per square inch for concrete with reservoir full and empty, respectively. For the reinforcing steel the adopted stresses were 10,000 lb. and 20,000 lb. per square inch under the same respective conditions.

In addition to difficult and special problems in the design of a multiple-arch dam, the laying out of the work in the field presented other special difficulties. This phase of the construction work has been noted in a report by Mr. E. C. Koppen, construction engineer, as follows:—"An extraordinary amount of preliminary study was necessary before the actual lay-out drawings for construction could be prepared. Basic data, such as arch thicknesses in three directions; the values of the various angles, offsets and stations of points on both surfaces of the arch at all elevations; also tables of angles and distances, had to be computed and formulæ developed for use in determining the many variables for laying out the work.

"How to prepare lay-out drawings for the closely spaced reinforcing steel dowels just inside of the trace of the arch on a steeply sloping and imaginary concrete footing, so that they could be readily understood by a gang of carpenters, was indeed a problem. The extrados string of dowels sloped with

the face of the arch, and the intrados string was vertical to fit the fillet on the downstream side. After several methods were tried the most workable method provided for the lay-out of a complete template constructed in place at footing level for each arch. These were built while final cleaning of foundation rock was in progress, grout holes were being located and grout pipes being driven and while much other work was being done in a very small area."

Geological formation of the rock at the site of the dam is in general a fine-grain granite to a depth of 400ft. and underlaid by granite of unusually coarse grain, the contact being a fused layer about 2in. to 4in. thick. Two rock faults extend across the river, but they are compactly filled and there has been very little movement along them. Foundation work was mainly in the fine-grained granite, but footings for the arches and buttresses had to be cut deep to reach thoroughly sound rock. This excavation was kept within close limits, and the trimmed surfaces were washed with water under pressure before concrete was placed. In the footings for arches and buttresses the excavations were shaped to roughly uniform slopes; steps and benches were avoided. Where joints or seams occurred their surfaces were cleaned by sand blasting to remove the coating of gritty mud.

Although the faults have little or no relation to the stability or support of the dam, they have some relation to the possibility of leakage beneath the dam. Wherever they were encountered in the footing excavations they were excavated for 3ft. to 5ft. below the normal level of the bottom of the footing, or into sound rock. At points where the faults passed out of the foundation area shafts were sunk to depths of 25ft. to 40ft.; grouting was carried 25ft. deeper and the shafts then filled solid with concrete.

Where the two faults crossed the excavation for footings of the arches and buttresses, 2½in. grouting pipes were placed about 5ft. apart, the pipes—driven 2ft. into the rock—being of such length as to extend above the concrete of the footing or cut-off wall. After this concrete had set holes 1⅜in. in diameter were drilled through the pipes by diamond drills to a depth of at east 25ft. below the bottom of each footing.

In the arch footings grouting was begun a few days after the footing concrete had been poured, and was completed before concreting of the arch was begun.

Grout of 1 part of cement to 1 to 5 parts of water, averaging 1 to 3, was forced by a duplex piston displacement pump having cylinders 3½in. by 10in. In feeding the grout, pressure ranged from 125 lb. to 175 lb., but was maintained as uniform as possible by regulating the power delivered to the pump. In this way, variable resistance to flow in the rock passages caused only a variation in the rate of pumping. For the final effort maximum pressure reached 250 lb. to 350 lb., but such pressures were maintained for only a few minutes. The 251 holes aggregated 25,680ft. in length, and took 20,230 sacks of cement. Several holes took from one to ten sacks per 1ft., but for 60 per cent. of the holes the average was less than half a sack per 1ft. During grouting operations a series of levels was taken in order to detect any tendency to uplift. Where indications of such uplift were noted the operations were modified or halted.

(To be continued)

Notes on Methods of Balancing

By K. R. HOPKIRK, M.A. (Cantab.)

No. III

(Continued from page 56, July 26th)

Limitations

THE conditions essential for accurate results are :

(1) The vibrations measured at the supports must arise from unbalance only.

(2) The transmission constants $\bar{A}_1$, &c., must not conform to the relationship

$$\bar{A}_1 \bar{B}_2 - \bar{A}_2 \bar{B}_1 = 0.$$

(3) The transmission constants $\bar{A}_1$, &c., must remain unaffected by the amount of unbalance.

Regarding condition (1), it may be said that vibration arising from causes other than unbalance can sometimes be compensated by balancing, but only with the final result of producing another vibration of a different nature or in a different location, due to the incorrect state of balance thus achieved. It is necessary, therefore, to eliminate other causes of vibration before balancing.

Condition (2) is violated when a rotor is running at a critical speed. The rotor and supports indicated in Fig. 1 constitute a system in which the

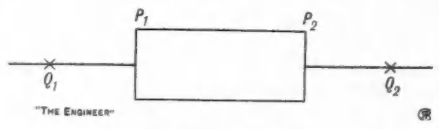


FIG. 1 (REPRODUCED)

mass and elasticity are approximately symmetrically distributed about a plane midway between the supports. If such a rotor were run at its first critical speed, when measuring vibration at support 1, the effect of a weight in a given radial direction in plane 1 would be indistinguishable in practice from the effect of the same weight in the same radial direction placed in plane 2. Thus, $\bar{A}_1 = \bar{B}_1$ and similarly $\bar{A}_2 = \bar{B}_2$, so that $\bar{A}_1 \bar{B}_2 - \bar{A}_2 \bar{B}_1 = 0$, and the measurements on the supports would not provide sufficient information to deduce the correct result. The actual result of balancing such a rotor at its first critical speed by the methods described above would be to compensate for the static unbalance, leaving a couple uncompensated.

The physical explanation of this particular case is that static unbalance causes appreciable bending of the shaft when running at the first critical speed, so that the vibration arising from the bent shaft is greatly in excess of the vibration which is produced by the actual unbalance forces, and also corresponds almost exclusively to the static component of those forces. A detailed discussion of such effects has been given elsewhere by the author.†

At or near a critical speed amplitude of vibration depends mainly on the restraining effects of frictional forces in the bearings and at bolted joints in the supporting structure. The relationship between amounts of unbalance and vibration produced cannot on this account be assumed to be linear. Furthermore, a very small change of speed will produce a large change in the angles of the constants $\bar{A}_1$, &c. The transmission constants cannot therefore be considered to be independent of the amount of unbalance, and any readings taken when running near a critical speed will be unreliable for purposes of exact calculation.

Instruments

When choosing instruments for the measurement of vibration it should be noted that instruments utilising the principle of mechanical resonance for the purpose of amplifying the vibrations are friction controlled, and are therefore not sufficiently accurate for calculating results. Instruments utilising seismometer type suspensions and optical or electro-magnetic amplification are quite satisfactory, providing that the amplifying devices are calibrated or are known to have a linear characteristic.

Fig. 8 illustrates the principle of a simple device which can be home made from components easily obtainable, and which measures amplitude of vibration with a high degree of accuracy providing only one frequency is present. This condition is necessary for accurate readings with any type of instrument. The weight W is rigidly attached to an arm pivoted at P to allow of free rotation about P. If pivots are not obtainable, small ball bearings, well cleaned and oiled, will suffice. The pivots P are fixed in a frame as indicated, and a contact C_1, attached to but insulated from the frame, provides a support for the weight. A second insulated contact C_2 is mounted in the frame above the weight and is adjusted to have a very small clearance, approximately 0·005in., when the weight rests on C_1.

A spring balance B or some other form of spring control is attached to the weight, as shown, so that pressure may be gradually removed from the supporting contact C_1, the amount of such pressure being measured on the scale of the spring control. An electrical circuit is required incorporating a pair of head telephones and a battery, connected in series between the contact C_1 and the weight. The contact C_2 is connected in parallel with C_1.

With the apparatus stationary the pressure between the weight and C_1 is $W = m\,g$, where m is the mass and g the gravitational constant. If the frame is held firmly in contact with a surface vibrating in a vertical direction, the weight will be vibrated vertically by means of the pressure $m\,g$. At the position of maximum upward displacement, an acceleration at least equal to $r\,\omega^2$, where r is the half amplitude of vibration and ω the angular velocity of the vibration, is required in a downward direction on the weight to maintain contact with C_1. If, by means of the spring control, the normal pressure between the weight and contact is reduced

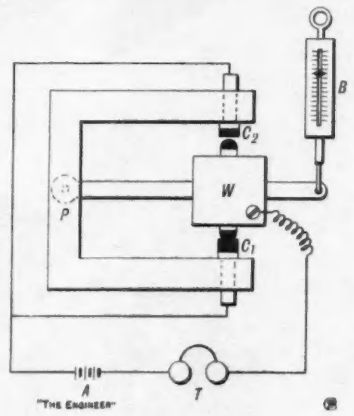


FIG. 8

to $k\,m\,g$, so that $k\,g = r\,\omega^2$, contact will just be broken as the frame commences to move downwards and a buzzing sound at the frequency of the vibration will be heard in the telephones. The half amplitude of vibration r then equals $k\,g/\omega^2$.

The value of k is found from the scale reading. With the apparatus stationary, let the spring pressure be increased until a click in the telephone indicates breaking of contact C_1, and let the scale reading be x. Let the scale reading when the buzzing starts with the apparatus vibrating be y.

Then $k = (x-y)/x$.

The amplitude of vibration is thus proportional to $(x-y)$ for a given frequency.

In order to measure horizontal vibrations the apparatus is turned through a right angle, so that the weight is suspended vertically from P. Contact is made with C_2 by increasing the spring pressure, and with the frame held firmly in contact with the vibrating surface, the spring pressure is adjusted until buzzing in the telephones commences. The amplitude of vibration in this case is directly proportional to the scale reading y.

For vertical vibrations of such large amplitude that chattering of the contact occurs before the spring is operated to reduce the pressure on C_1, the direction of the spring pressure must be reversed, or, alternatively, if it can only be applied in one direction the frame can be turned upside down, so that contact C_2 is used as support. The amplitude of vibration in either case is directly proportional to $x+y$.

The author has made and used with good results an instrument constructed on these general principles. So far as he is aware, the construction is not the subject of any patent.

The simplest of all instruments is the marking pencil, but the pencil must be used with skill and discrimination, and the markings correctly interpreted. The following conclusions arise from a consideration of the dynamic aspect of the problem involved in making a shaft marking :—

(1) It is essential that the portions of the shaft marked should be smooth and truly concentric with the journals. If this condition is not fulfilled, the result will be similar to that found in measuring amplitude of unbalance vibrations when extraneous vibrations are also present.

(2) The method is not suitable for shafts supported in ball or roller bearings, unless special provision is allowed for transverse movement of the pedestals. Such movement should not arise

† B.T.H. Activities, March-April, 1934. "The Balancing of Rotating Machinery," K. R. Hopkirk.

from amplification due to running near a resonant speed.

(3) With shafts running in sleeve type bearings, the maximum displacement from unbalance forces is along a diameter tilted with respect to the horizontal diameter. For clockwise rotation this diameter would extend from ten or eleven o'clock to four or five o'clock. The pencil should therefore approach the shaft in a radial direction at approximately ten o'clock for clockwise rotation or two o'clock for counter-clockwise rotation.

(4) The pencil should approach the shaft very slowly and with a uniform light pressure. It may make contact at any instant during a revolution, so that the position of the leading end of the mark should be ignored. If correctly held, it will cease to maintain contact at the instant when the shaft has its maximum displacement towards the pencil. The theory involved is similar to that outlined for the operation of the instrument illustrated in Fig. 8. The lagging end of the mark is therefore the measure of the relative angular displacement. Several marks side by side should record the same angular position at their lagging ends, and unless this result is achieved, the method is of little use.

It must not be assumed that the shaft marking directly indicates the position in which to add balance weights. The result must be calculated by the third method already described.

(5) A heavily weighted pencil should be much easier to control than a light one. The force exerted on the pencil by the shaft when the two are in contact, and the shaft is moving towards the pencil, is proportional to the mass of the pencil. Increased mass therefore requires a greater force to maintain contact after the instant of maximum displacement of the shaft. A further improvement would be to arrange the pencil to move in a guide radially towards the shaft, and against a spring tending to draw it away from the shaft.

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Strategic Minerals in the United States

A REPORT presented by the United States Bureau of Mines to the Secretary of the Interior details the results of the first nine months of the strategic minerals survey being conducted jointly by the Bureau and the Geological Survey. Although the United States is far from being self-sufficient in strategic minerals, the general outlook for discovering important domestic deposits is stated to be definitely more encouraging than anticipated at the start of the search. The situation with regard to five minerals—essential in peace and critical in war—is somewhat promising. These minerals are manganese, chromite, tungsten, mercury and antimony. The nickel situation is less encouraging and that of tin is classed as rather negative.

The importance of discovering and developing useful deposits of the major strategic minerals is shown by the heavy percentages of these minerals which must be imported at the present time. The following table shows the percentage of the nation's peace-time requirements produced from domestic mines during a recent five-year period :—

	Per cent.
Manganese	5–6
Chromium	1
Mercury	40
Tungsten	50
Nickel	0·5
Tin	0·2
Antimony	10

Field examinations have been made during the survey of 162 deposits of strategic minerals. Of these, thirty-three are considered to be of sufficient interest, from the standpoint of constituting possible strategic reserves, to warrant some exploratory work involving sampling by trenching, tunnelling, test pitting or diamond drilling or by a combination of these methods. In addition, about 250 deposits are considered to be of enough interest to warrant preliminary examination. Actual exploratory work has been conducted by the Bureau on nine different projects, of which one is an antimony deposit in Idaho, three are chromite deposits in Montana, Wyoming and Oregon, one is manganese in Washington, one nickel in Nevada, two tin in South Dakota and New Mexico, and one tungsten in Nevada. The results have been sufficiently encouraging to warrant further work on six of these projects, and on four of them this further work is now being done or is being planned. In all the projects examined by the Bureau some new ore bodies were found, although they were not generally of commercial grade. It is pointed out, however, that, for availability as strategic reserves, it is not essential that deposits should be of commercial grade.

On manganese, the most important of the strategic minerals, actual exploratory work was done only in one locality, because there were so many manganese deposits to be considered that the most promising could not be selected immediately. It has now been possible to select from the manganese deposits considered forty-seven that warrant exploratory work, and during the next fiscal year it is proposed to give precedence to the exploring of manganese deposits. The nation's reserves of low-grade manganese deposits are large; the problem is to devise metallurgical processes that may make some of these low-grade reserves available for strategic demand. One small lens of high-grade manganese ore was discovered which will not add to the strategic reserves, because it is of such grade and quality that it probably will be quickly mined out and the ore sold at a profit. Of interest, however, is the fact that the drilling cost was only about 1 dollar per ton of ore indicated, the value of which is 30 dollars per ton or more at prevailing prices. Imports of manganese ore in the past have been mainly from Russia, Cuba, the African Gold Coast and Brazil.

Extensive deposits of chromite of a grade that could probably be used in an emergency are indicated in one locality. Further exploratory work by trenching and diamond drilling was resumed in June for the purpose of definitely proving the existence of sufficient tonnage to be of real strategic importance. Metallurgical investigations on this ore, which is not up to standard grade, indicate that a high-grade ferrochrome product can be made, although at a cost somewhat above the normal price of this alloy. Imports of chromite have been largely from Southern Rhodesia, Union of South Africa, Philippine Islands, Turkey and New Caledonia.

A large low-grade deposit of antimony ore has been indicated by diamond drilling. Although subcommercial in grade, this deposit could furnish a substantial percentage of the country's requirements in an emergency at a price considerably above the prevailing one. Some high-grade antimony ore has been discovered in small lenses and it is believed that, in the general area in which they occur, these small deposits would, in the aggregate, constitute an important reserve. The greater part of the country's antimony imports before 1931 came from China; since that date Mexico has become the principal source of imports.

The outlook for the United States becoming self-sufficient in tungsten is stated to be very good, largely as the result of the efforts of private enterprise. In the case of mercury, the prevailing high price has stimulated production from lower-grade domestic deposits to a rate equal to the requirements of industry, although the length of time this rate of production can be continued is problematical. Two or three nickel-bearing deposits were discovered that are of sufficient promise to warrant exploratory work and sampling. The great bulk of production previously has come from Canadian deposits. Tin reserves have not been disclosed. It would be impossible to produce any large amount of tin even from the low-grade ores which have been found. One small ore shoot was partially delineated to a depth of about 300ft. and found to contain enough tin to enable it to be worked at prices about double the prevailing market price. There might be a considerable amount of similar material at depths below that which was prospected. The United States normally consumes about 75,000 tons of metallic tin or half of the world's supply. Of this, about 40 per cent. is used in making tin-plate, 30 per cent. as solder and bearing metals, and the remainder as foil and in miscellaneous ways. In recent years about 75 per cent. of the world's supply of tin has been derived from placer deposits in the Malay States and the Dutch East Indies.

Canadian Engineering News

Algoma Steel Developments

Two major developments were carried out by the Algoma Steel Corporation, Ltd., in 1939—completion of its sheet and tin-plate mill, followed by the opening of the New Helen Mine by Algoma Ore Properties, Ltd., a wholly-owned subsidiary. The sheet and tin-plate mill, built at a cost of approximately 2,000,000 dollars, added 30,000 tons a year to Canada's capacity in flat steels. The mill is working on a capacity basis, and with the reduction in tonnage of such steels available from Great Britain owing to war conditions, it has been decided to double the output of the plant this year by the installation of additional mills and auxiliary equipment. Contracts have already been let, and it is estimated that the work, including additional building to house the new facilities, will require about six months to complete. The opening of the New Helen Mine marks the first mining of iron ore in Canada since the closing of Algoma's Magpi Mine in 1921. The new enterprise taps a 100,000,000-ton deposit of siderite ore, increases its commercial value by raising its iron content to 53 per cent. by the sintering process, and provides Canada with a domestic supply of raw material essential to national progress. Other developments—less outstanding but in total of considerable importance—include a new furnace for the more efficient and more uniform heating of splice bars in preparation for punching and notching; introduction of a new flat piling (type "D"), to round out Algoma's range of Canadian made shcet piling, and construction of a third 2,000,000-gallon oil storage tank and addition of oil pumping equipment.

Steel

Canadian steel operations, which this year have been running at more than twice the level of early 1939, partly on foreign business and partly because of increased domestic requirements, have been buoyed by a steady influx of orders from countries outside the war zones. These countries, which before the war had obtained their steel needs from European countries, such as Germany and Britain, have been unable to obtain their requirements in recent months from Europe owing to the fact that European industry has been fully engaged in war production. Some of the countries outside the war zone, particularly those in South America, Africa and southern Europe, have been buying from the United States, but others, including Empire countries, have looked to the Canadian industry for their supplies. An instance of this foreign business that is coming to Canada are orders for nearly 3,000,000 dollars of steel products recently announced from South Africa. This business includes an order placed by the South African Railways and Harbour Administration for 57,000 tons of steel, valued at 2,800,000 dollars, which has been divided equally between the Dominion Steel and Coal Corporation and the Algoma Steel Corporation, and an order for 85,000 pairs of fish plates. British purchases from the Dominion Steel Corporation also have been increased since the war started, necessitating maintenance of expanded production facilities.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

LEADED GUN-METAL CASTINGS AND INGOTS

(B.S.S. Nos. 897, 898, 900, 901.)—There has in the past been a standard for only one type of gun-metal alloy, namely, 88/10/2 (copper, tin, zinc), bronze (gun-metal) ingots and castings (B.S. 381 and 382).

The Institution has, however, just issued standards for two further leaded gun-metal alloys of the compositions 85/5/5/5 and 87/9/3/1, respectively. They form the subject of two publications, each of which includes separate specifications for ingots and castings, and the form of the specifications follows the lines previously established for the bronze gun-metal castings specifications. The specifications have been based on proposals put forward by the Institute of British Foundrymen as a result of a considerable amount of experimental work which was carried out by one of its committees. The tensile strength of the 85/5/5/5 alloy is 12 tons per square inch, and that of the 87/9/3/1 alloy 14 tons per square inch.

COLD-ROLLED COPPER SHEET

(B.S.S. No. 899.)—So far there has been no British Standard Specification for copper for general engineering purposes, although there is a useful series of specifications for copper for electrical purposes. This deficiency has been made good and a British Standard for cold-rolled copper sheet and strip (half-hard and annealed) for general engineering purposes has now been published. This specification supersedes the specification which existed in the Aircraft Series—No. 2 B 15—for copper sheets for aircraft purposes, and which will now be withdrawn. The composition clause has been so framed that an arsenical copper can be provided under the specification if desired. The tensile strength of the material is 17 to 21 tons for half-hard material and 13·5 to 17 tons for annealed material, in thicknesses from 3 S.W.G. (0·252in.) and thinner, and in widths up to 42in.

ENGINEERS' PARALLELS (STEEL) AND DIAL GAUGES FOR LINEAR MEASUREMENTS

(B.S.S. Nos. 906 and 907.)—Two further specifications have recently been issued in the series of British Standards for Engineers' Precision Tools. The specification for engineers' steel parallels deals with the general dimensions and permissible errors in parallel blocks of sizes ¼in. by ¼in. by 4in. to 2in. by 4in. by 16in. Provision is made for two grades of accuracy, one for high-precision work and the other for general toolroom use. The specification for dial gauges applies to the most commonly used type of gauge, in which the plunger movement is parallel to the dial. It does not cover gauges with a back plunger movement. The main purpose of the specification for dial gauges is to establish standards of accuracy. Considerable latitude is allowed in the general design of the gauge, although certain requirements are included in respect of matters of detail where these have a direct bearing on the initial accuracy or the maintenance of the accuracy or on the ease with which the dial gauge may be read. The tables of permissible errors cover dial gauges from 1¼in. to 2in. diameter, measuring by steps of 0·001in., 0·005in., 0·0001in., and 0·01mm. The appendix to the specification gives notes on various methods of testing dial gauges, with particular reference to the accuracy of calibration.

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Contents

THE ENGINEER, August 2nd, 1940 PAGE

A SEVEN-DAY JOURNAL 67

LEADING ARTICLES—
- THE INSTITUTIONS AND THE WAR 74
- WAR-TIME TRANSPORT 74

SPECIAL ARTICLES—
- AUTOMATIC TRAIN CONTROL. No. IV. (Illus.) 68
- BARTLETT MULTIPLE-ARCH DAM, U.S.A. No. I. (Illus.) ... 71
- NOTES ON METHODS OF BALANCING. No. III. (Illus.) ... 72
- COMBUSTION GAS TURBINE. No. II. (Illus.) 78
- COOLING QUENCHING OIL. (Illus.) 80
- REFRIGERATION FOR DURALUMIN RIVETS. (Illus.) 81
- STRATEGIC MINERALS IN THE UNITED STATES 73
- TURBINE BLADE FATIGUE TESTING. (Illus.) 80
- WATER SOFTENING TREATMENT BY UPWARD FLOW. (Illus.) 79

LETTERS TO THE EDITOR—
- PUMP LOSSES AT VARIOUS SPECIFIC SPEEDS 76
- THE PROCESS OF COMBUSTION IN INTERNAL COMBUSTION ENGINES 76
- PRODUCTION PROBLEMS 77
- GLASS FIBRE ELECTRICAL INSULATION 77

LITERATURE 75
- BOOKS RECEIVED... 76
- SHORT NOTICES 75

NEWS AND NOTES—
- BRITISH STANDARDS INSTITUTION 73
- CANADIAN ENGINEERING NEWS 73
- CATALOGUES 82
- MARKETS, NOTES AND NEWS 81
- NOTES AND MEMORANDA 82
- SIXTY YEARS AGO 77
- TECHNICAL REPORTS 75

NOTICES TO READERS

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THE INSTITUTIONS AND THE WAR

THE engineering Institutions are already doing much to further the vigorous prosecution of the war. Even before it began—during the September crisis of 1938 that seems now to lie in the far-distant past—they set about the preparation of registers of the accomplishments of their members, and those records have since formed an important part of the National Register which covers the whole country. Since the actual outbreak of hostilities they have been actively engaged upon satisfying numerous applications made to them by the Government Departments and individual firms for the names of engineers suitable to fill new or vacant posts. In addition, members and others in urgent need of accurate technical information have made application to the library staffs for references, and some of the Institutions have been able to place research facilities at the disposal of the authorities. In fact, there is not an engineering Institution in the country that has not offered its services in some suitable capacity to the Government. Members have, however, suggested that more direct contributions to the war effort might be made. In that connection, Sir Clement Hindley, President of the Institution of Civil Engineers, pointed out at the recent annual meeting that a large majority of members were individually engaged in important duties, and were contributing to the full their individual effort. The Institution could not mobilise any large number for special work, as could be done in the great industries which had powerful organisations of employers and labour. He added that the Institution was ready to do anything that it might be asked to do, and that in pursuance of that policy it had recently offered its services jointly with the Institutions of Mechanical and Electrical Engineers to the Prime Minister for any work of which the Institutions or their members might be capable. From the reply which the letter referred to by Sir Clement evoked, the Institutions know that their offer is being considered by the Government Departments principally concerned.

Since many of the inquiries directed to the Institutions are no doubt of a secret nature, we are no more aware than are members precisely what use the Government is making of these sources of information. It may, however, be perhaps suspected, since at this late date it has been thought worth while to make a direct approach to the Prime Minister, that the Institutions believe a considerably greater use could be made of the services they have to offer. It can bear repetition that this is an engineers' war. In past wars, given reasonable equality in numbers and in leadership, that army which had the better men won the most battles. But now the quality of the personnel of the Army counts for less than the scale of its equipment. A man with a rifle is no match for a tank, however high his courage. In the long run only the aeroplane can beat the aeroplane. Machine must be matched against machine, and to that nation that produces the better machines in the requisite number will be the victory. High technical excellence must march with great productivity. As engineers, we know that these two things are not wholly reconcilable. But it is for the mechanical engineer to solve the problem how to raise continually the quality without thereby affecting productivity; for the mining engineer and the metallurgist to maintain supplies; for the electrical engineer, amongst other matters, to ensure the generation of sufficient power. For the civil engineer is reserved rather a different task. Of old, civil engineers took that title to distinguish them from their military brothers who had formerly carried out both military and civil works. But to this day the connection remains. There is not so much difference between civil and military needs that the civil engineer cannot turn his hand to a military task. Indeed, when the exigency of war calls for the carrying out of large-scale operations he can claim to have advantages. For in times of peace relatively few military engineers have the opportunity to gain experience of large-scale operations. It is therefore praiseworthy in them if, when works on a scale outside their experience have to be undertaken, they call to their aid their civil colleagues. In addition to the direct aid he can thus give to the military, the civil engineer has it in his power to advise on other matters. Let the military choose a target, and the engineer can show him where best to direct his explosives so that the greatest damage shall be caused and that which will create the greatest disturbance and the greatest difficulty in repair. For every engineer, whatever his denomination, there is some task in war for the performance of which his special knowledge fits him.

All the engineering Institutions have capable men amongst their members willing to put their specialised knowledge and experience, gathered not only in this country but also overseas, at the service of the Government Departments. Thus, although, to adapt Sir Clement's words, the Institutions have no organisation of the kind that would enable them to allot their members to specific work for the assistance of the Government, they could assist in any specific problem by placing before the Government the names of members who have special knowledge and experience. It would be regrettable and would contribute to a lengthening of the war were the Government Departments to neglect the storehouse of special knowledge thus laid open for their use. The Institutions are already doing much. But we are disposed to wonder whether, if some simple machinery were set up which would ensure that in all matters that concerned them they would automatically be consulted by the Government Departments, the Institutions might not be able to prove themselves of even greater value than they are at present.

War-Time Transport

As will no doubt be readily recalled, the declaration of war last September checked the coming into operation of proposals, originating in the "Square Deal" campaign of the railway companies, for a closer agreement between competing forms of transport in this country. That agreement, it was confidently expected, would have proved successful and would have led eventually to a higher degree of co-ordination. The railways sought immediate relief from certain existing statutory regulations, particularly in relation to their charges. In return they offered certain safeguards for the interests of trade and industry; came to an agreement with road interests to set up the Road and Rail Conference to consider the principles on which voluntary agreements could be entered upon regarding charges; agreed that certain statutory regulations applicable to canals should be repealed; and showed themselves willing to take part in regular conferences with representatives of coastwise shipping. These proposals were put before the Minister of Transport by the Transport Advisory Council in April, 1939, and had the war not intervened the necessary legislation to give effect to the scheme would have been introduced before Parliament in the autumn. With the coming of war the State assumed differing degrees of control over all forms of transport. The railways, obtaining increased traffic, made better profits; but the limitation of petrol supplies heavily affected road transport; the waterway industry asked unsuccessfully that the Government should take over the canals with a guarantee of net receipts, as was done in the third year of the last war; and coasting lines and small coasting tramps suffered a shortage of traffic.

A demand arose as a consequence of these circumstances for an independent review of the distribution of traffic between the different forms of transport. In February last the Minister therefore submitted to the Transport Advisory Council terms of reference which, after amendment, called upon the Council "To consider whether those whose business it is to provide the different forms of public transport of goods in this country can, by some substantial rearrangement of methods of working in time of war (as a result of agreement among themselves or of governmental direction, including direction as to the allocation of traffic), provide in the national interest more efficient services than those which under existing conditions are likely to be available." After considering a number of memoranda submitted by interested parties the Council adopted a Report on May 30th. It recommended that the division of traffic between the four branches should normally be effected by voluntary allocation of traffic by mutual agreement, and that to put this system into action there should be constituted a small Central Committee, consisting of representatives of the four forms of transport and of the Ministries of Transport and Shipping, with an independent chairman, to advise the Minister and plan the best use of transport. Regional Committees were also to be set up in each Civil Defence Region and, if necessary, Sub-Committees for smaller areas. These Committees would effect local agreements for the allocation of traffic and keep in touch with Regional Transport Commissioners. It was further recommended that consideration should be given to the fuller use of water transport by Government Departments for moving goods which they owned or controlled. On July 12th the Council was informed that the Minister had rejected its recommendations on the grounds that since they had been drawn up circumstances had radically altered and that the attempt to make so drastic a change in the method of control could not now be justified. It was added that powers already existed for the allocation of traffic in war-time conditions.

To judge from the Council's Report, the Council is not in agreement with the Government regarding the adequacy—or perhaps we had better say organisation—of the present control. For it is

definitely stated in the Report that there is "at present no control of the division of traffic between the four forms of transport" with the end in view that the organisation of each shall be efficiently maintained. Limitation of liquid fuel supplies restricts the operation of road vehicles, but "the machinery for fuel allocation was not designed to serve as an instrument of traffic allocation." The Ministry of Shipping exercises control of coastwise shipping, but it "is in no sense a control over the distribution of traffic as between the four forms of transport." Other Government Departments, notably the Ministry of Supply, Ministry of Food and the Services, exercise control "by reason of their position as controllers or consignors of goods." But "All these controls are piecemeal, limited and unco-ordinated one with another." It needs to be remembered, however, before any conclusion be drawn from those arguments, that, as the Minister of Transport pointed out, circumstances have radically altered since those words were written. We are not in a position to know what action the Government is taking to remedy a state of affairs that appeared to the Council undesirable nor to know what effect the changed circumstances have had upon the use made of the four forms of transport. Judgment upon the matter, it seems, must therefore wait upon further enlightenment. In the meantime it is interesting to note how the Council in its proposals, intended only to meet a war-time emergency, has nevertheless built upon the voluntary basis of the "Square Deal" agreements. Its proposals, shelved now, will bear re-inspection when peace has returned again and the four forms of transport once more come to a consideration of co-ordination.

Literature

Elements of Sanitation. Edited by E. S. HOPKINS. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. 1940. 21s. net.

HERE is an American publication containing twelve monographs dealing with as many aspects of the subject-matter. The average length is between 35 and 40 pages, and each has been written by men actually engaged in the work of which he writes. Three of the chapters deal with the gathering, filtration, and treatment of public water supplies; two cover sewage disposal and problems arising out of the discharge of trade waste into streams and rivers; and two others with the preservation of food and milk sanitation. Here also are chapters on ventilation and air conditioning, on the control and maintenance of swimming pools and on environmental hygiene. The last-mentioned term serves to provide a reason for gathering up points which none of the other authors managed to review, and although the chapter is the last in the book, it is typical of the approach of each author to his own subject. It opens with a note on carbon monoxide and covers dust, smoke, odours, mosquitoes and rats, not to mention a dozen other sources of possible trouble to the community.

Now it is obvious that a score of nuisances cannot be considered fully in forty pages, nor is that sufficient space in which to discuss any single phase of sanitation. Yet Mr. Hopkins and his associates have achieved something akin to success because each author has recognised the limitations of space. Instead of generalisations, each seems to have selected for consideration salient features arising out of modern practice. The word used may appear to qualify the last sentence, but really this book should be reviewed by as many experts as there are authors. Still, the present reviewer has found that his own particular fields are satisfactorily treated, and as one of them has been written by the editor-in-chief, a fair inference is that other experts will not be disappointed. Perhaps the most topical article from the British point of view is the one on "Refuse Disposal." In view of the efforts that are being made in certain municipalities—efforts that are being fostered by a not too well-informed daily Press—a short section devoted to "the problem of the garbage-fed hog" is apposite.

The Switchgear Handbook: Vol. II, Application. Edited by W. A. COATES, M.I.E.E., F.A.I.E.E., and H. PEARCE, B.Sc. (Eng.), M.I.E.E. London, 1940: Sir Isaac Pitman and Sons, Ltd. Price 21s. net.

THIS is the sequel to an earlier symposium on apparatus, written by members of the engineering staff of Metropolitan-Vickers, which we reviewed in these columns just eighteen months ago. The present symposium again covers an extensive field, this time with considerably greater care in the choice and presentation of the material at the disposal of the editors.

The book opens with a relatively long chapter on the technique of calculating short-circuit currents, including the use of symmetrical component theory in dealing with unbalanced faults. It is followed by three well-written and most useful chapters devoted to the main circuits of power station and sub-station bus-bars and their connected plant, to the control of power station auxiliaries (where continuity of supply is the overriding consideration), and to the main and control circuits of all types of electrical plant, ranging from generators and transformers to meters and control gear. Next comes a short chapter on circuit breaker selection, followed by four excellent descriptive chapters dealing with metal-clad gear, cubicle and truck type gear, mining gear, and low-voltage switchboards. Two further valuable chapters cover the lay-out and design of E.H.T. outdoor switching stations, and of small outdoor sub-stations, including kiosks and pole type installations. Then follows a general chapter on control boards, which ends by attempting to summarise the techniques of supervisory control, telemetering and automatic electric control, but which fails to do justice to such an important subject. The handbook concludes with a short chapter on installation tests and maintenance and with a brief note on those regulations that affect switchgear engineering practice.

This new volume succeeds in compressing a great deal of useful information on a wide range of allied subjects into the space of some 260 pages, while references to more specialised sources of information are given at the end of each chapter. Both text and illustrations have been edited with evident care to represent modern British practice in the application of switchgear to the control of electric power in all its phases. Like the preceding volume, it is a valuable addition to switchgear literature which deserves to find a place on every electrical engineer's bookshelf.

A History of the Great North of Scotland Railway. By SIR MALCOLM BARCLAY-HARVEY, K.C.M.G. London: Locomotive Publishing Company, Ltd., 4, Amen Corner, E.C.4. Price 10s. net.

BIT by bit the story of the smaller railway companies that survived the financial crises of the last century is being told by those in positions to get access to the facts. Perhaps someone will write in the future a comprehensive history of railways and railway engineering working backwards. By that we mean the author will start with the system as he finds it when he writes his book and will trace each of the existing companies back to their origins. If ever that task should be essayed, that writer should bless the historians of the sectional railways, for in their pages he would find plenty of facts and, what is hardly less important, pointers to sources from which to obtain additional information. Sir Malcolm Barclay-Harvey is an admirable example of the sectional historian in this field of engineering records. He knows well that corner of Scotland which lies between Inverness and Fraserburgh on the Moray Firth coast and Aberdeen and Ballater in the South. He knew also where were the records upon which his story had to be based, and he was able to claim the assistance of others with special information on matters of detail. What was more profitable, he was not in a hurry to finish his book. Hurry is a handicap and a pitfall in such case, for little facts which throw light on problems hitherto unsolved have a trick of turning up late. Sir Malcolm tells us that his book has been seventeen years in the writing.

The Great North of Scotland Railway goes back to 1844 and was one of three rival schemes which had Aberdeen as the centre from which a scheme was to be launched. Sir Malcolm's first chapter is just one of many stories of the financial worries that befell most of the pioneers of railways. Somehow the original budgets of promoters never did cover the provisional estimates, and it was not until November 25th, 1852, that the first sod was cut. The "Great North" was not the first railway north of Aberdeen; that honour lies with an enterprise that was known as the Morayshire Railway, planned to connect Inverness, Nairn, Elgin and Lossiemouth. Only one section was actually completed and in due course that venture was absorbed in the greater one which is the subject of Sir Malcolm's monograph. How this and other similar schemes were ultimately merged into one are told in three consecutive chapters. There were years of struggle, but somewhere about seventy years ago the Great North of Scotland Railway began to make progress. In his concluding chapter the author has summarised the post-war amalgamation with the eastern group of British railways.

For the rest those interested will find plenty of biographical notes about the men who made the Great North a factor in Scottish railway transport, while others who revel in rolling stock and locomotive lore are given a goodly share of space. The pictures are particularly well done. The frontispiece is a reproduction in colours of an oil painting of the Deeside express, while no fewer than thirty engines are shown either as line drawings in the text or reproduced by the photogravure process used for the plates, of which there are nearly fifty. The book is certainly a cheap one.

Memories of People and Places. By SAM MAVOR. London: W. Hodge and Co., Ltd., 86, Hatton Garden, E.C.1. Price 10s. 6d. net.

THE author of this volume of reminiscences is the chairman of the electrical engineering firm in Glasgow with which his name is associated. It is a scrap book, but a good one, a gathering-up of the best that the author has written for a house organ published by his own company, plus two longer articles on Russia. The last-named are based on travel talks to the members of the Royal Philosophical Society of Glasgow. We can leave them to the readers of the book. The remaining pages are those that will appeal to men who have lived through the years that have prompted Mr. Mavor's memories. Without any plan, he recalls in Part I people who have crossed his track at home and abroad, in business and out of it; and what a gallery! His references to Colonel Crompton, with whom he was associated in the days when electric lighting was getting into its stride, makes lively reading, and may provide future historians with facts not otherwise obtainable. There are pen portraits, sketchy in style, of Sir John Fowler and Sir William Arrol, of Forth Bridge fame. They were men with whom Mr. Mavor made business contacts, but he is as happy with very different types—Prince Peter Kropotkin, the Russian "aristocrat, revolutionist, patriot, internationalist, scientist, and visionary." That is the author's own list, and in the space of six pages each quality is somehow indicated. The rescue of Percy Pitcher from oblivion and the placing of his record among those of the pioneers of flight is another example of Mr. Mavor's use of the unexpected, and even more unexpected in a book by an engineer are the stories of Cunningham Graham, Rodin, Scott, Haldane, Fletcher Moulton, and the Prime Minister's mother. Mr. Mavor has enjoyed meeting these and scores of other notable people; he has had the seeing eye, the observant mind, and a retentive memory which, joined to the pen of a ready writer, have resulted in this collection of amusing impressions of people.

Part II, "Memories of Places," makes more solid reading. In addition to the Russian papers, here are accounts of visits to Baku, Japan, South Africa, Jamaica, the Falkland Islands, and Canada, along with one about a voyage in a Zeppelin. And how Mr. Mavor has enjoyed all his opportunities "for indulging a taste for world vagrancy and the experiences it brings"! Now, at seventy-seven, he has reached the stage "when a man begins to prefer leisure rather than adventure," and his book which "was not premeditated, . . . has just happened."

SHORT NOTICES

Photo-Electric and Selenium Cells. Second edition. By T. J. Fielding. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 7s. 6d. net. —The new applications and advances which have been made in the design of the light-sensitive cell since the publication of the first edition of this book,

in 1935, have necessitated extensive revisions. Many chapters have been completely re-written, and a section on time delay circuits has been included in the new edition. The author describes several new applications, each having been selected as representative of a type, the principles of which are applicable to a number of other existing or potential uses.

BOOKS RECEIVED

A Primer of Time Study.—By F. W. Shumard. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 33s.

Elements of Sanitation. Edited by E. S. Hopkins. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 21s. net.

Philips Practical Welding Course. London: Philips Lamps, Ltd., Century House, Shaftesbury Avenue, W.C.2. Price 3s. 6d. net.

Aircraft Identification. Part I, Fighters and Bombers. Fourth edition. London: *The Aeroplane*, Bowling Green Lane, E.C.1. Price 2s. net.

Industrial Surveys and Reports. By W. Rautenstrauch, LL.D. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 15s. net.

Memories of People and Places. By Sam Mavor. London: William Hodge and Co., Ltd., 86, Hatton Garden, E.C.1. Price 10s. 6d. net.

TECHNICAL REPORTS

Economical Type Designs in Reinforced Concrete for Single-Storey Factories: War-time Building Bulletins Nos. 5 and 6. H.M. Stationery Office. Price 1s. net each.—In an earlier bulletin of this series (No. 2) the broad principles for the use of reinforced concrete in war-time building were outlined, and in this bulletin, No. 5, just published by the Building Research Station of the Department of Scientific and Industrial Research, type designs are given which illustrate the application of these principles to the problem of the single-storey factory. The roofs consist of reinforced concrete slabs with a raised section providing a continuous lantern with vertical lights, and drawings are provided for spans of 30ft. and 40ft. and for column spacings of 15ft. and 27ft. A table shows the weights of steel demanded by these proportions, but if maximum economy is to be achieved it is of the utmost importance that spans and column spacings should not be wider than is absolutely necessary. The loads and stresses for which these designs have been prepared are given, and a suitable concrete mix suggested, while roof drainage, foundations, and daylighting are also discussed. Two appendices deal fully with the shuttering required for these designs and for the roof slabs of type A described in Bulletin No. 1 of the series. "War-time Building Bulletin No. 6" is in two parts. Part I introduces a new method of vault construction which eliminates the use of reinforcement and also the need for temporary centring, specially shaped concrete blocks, requiring no reinforcement, being used to form barrel-shaped vaults. The blocks are of a kind which can be made by any concrete specialist or competent building contractor, and speedy erection is possible, while much of the labour can be unskilled. An experimental structure of 20ft. span has been erected at the Building Research Station, and a 12ft. span structure is at present exhibited at the Building Centre, 158, New Bond Street. Obviously, at the present time, there are many possible applications of the idea. Part II of the bulletin is really a supplement to "Building Research War-time Building Bulletin No. 3" on "Huts," and gives details of two designs which were only briefly referred to in the earlier bulletin. The application of three type designs to multiple-span hut schemes is also shown.

House Construction: War-time Building Bulletin No. 7. H.M. Stationery Office. Price 1s.—Shortage of timber practically prohibits its use to-day for house building. As a result, some form of construction that uses steel reinforcement must be employed. This bulletin issued by the Department of Scientific and Industrial Research, sets out certain standards by which to judge proposals for war-time houses, and economy of steel is the first consideration. To obtain figures with which to make comparisons, two typical designs for small houses have been examined, and their constructional details worked out. Tables are given to show how much steel would be needed to erect these houses, using either "precast" or "in situ" construction. Although methods of construction in situ require considerably less steel, they need more shuttering than the precast systems. To obtain these data a hollow tile and concrete construction was chosen, but it is emphasised that many other forms of construction might give equally good or better results, and that the results obtained are intended to set only a maximum limit to the steel which can be permitted. Tables are given showing the possibilities of this hollow tile type of construction, both in precast and in situ forms. Considerable stress is laid on the importance of proper planning for war-time conditions. Spans must be kept small and cross walls used for load carrying whenever possible. Flat roofs are stated to be more economical in steel than pitched roofs, and must therefore be used, even if at some later date it is felt necessary to alter them. Heat insulation is more important with flat roofs than with pitched roofs, and a section on this subject is included, with a table showing comparative values of different forms of roof. A section deals with the possibility of trouble from smoky chimneys on flat roofs. Air raid precautions are mentioned, and it is shown that practically no increase in steel is required to make the flat roofs resistant to light incendiary bombs. There is also a suggestion that in houses having a small room, such as a bathroom on the ground floor, air raid shelters might be constructed within the house with only small alterations in structure. Sound insulation between houses is considered, and it is pointed out that by adopting proper methods very good results can be obtained at comparatively little additional expense.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PUMP LOSSES AT VARIOUS SPECIFIC SPEEDS

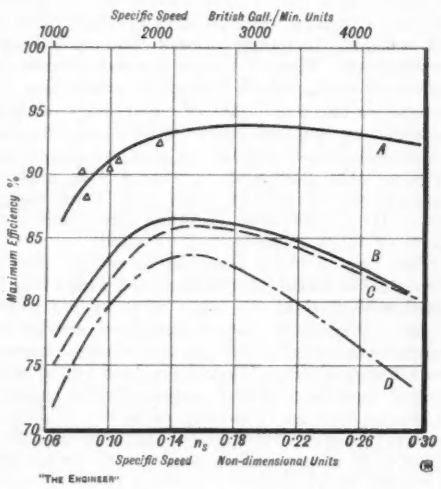
SIR,—In connection with Mr. McDonald's remarks[1] on the variation of the efficiency of pumps with specific speed, and on the various published curves and figures, the following notes may be of interest.

Pump losses are of three different forms:—

(1) Mechanical—bearing and disc friction,
(2) Volumetrical—leakage loss,
(3) Hydraulic—loss of head in stationary and rotary passages.

Disc friction has already been shown to decrease in proportion to the energy output as the specific speed increases.[2] Bearing friction will be less important at high specific speeds because of the usually higher outputs of these machines. Also, since higher specific speeds mean larger discharges at lower heads, the leakage losses will also decrease as specific speed increases. It remains, therefore, to consider the hydraulic losses.

Since the optimum efficiencies only of a series of pumps are in question, shock at inlet and exit from the impeller may be presumed non-existent, and the losses will therefore be comparable with those through straight channels of varying section. The diffuser is a divergent or a series of divergent channels. The impeller passages must also in general be divergent rather than parallel or convergent. The reasons for this are as follows:—The pressure rise within the impeller is due to the resultant of two actions: (*a*) centrifugal action, and (*b*) divergent channel action. The latter may, of course, be zero or negative, but if it is so, the impeller must be larger and have longer channels than if it is positive. A larger impeller means higher disc friction, and longer channels mean higher skin friction. At very low specific speeds these are already dominating factors and therefore a divergent design is a necessity. At very high specific speeds the centrifugal pressure rise becomes small, due to the d_1/d_2 ratio being large, so that full advantage must be taken of increase of pressure due to retardation within the impeller. If divergence is a necessity at the extremes of the specific speed, then it may be assumed to offer advantages over the whole range.



A—Curve plotted from equation given with $k=0\cdot15$, and other losses added,

B—Curve plotted from equation given with $k=0\cdot40$, and other losses added.

C—Curve for volute pump given by Sherwell and Pennington.[4]

D—Curve given by Daugherty, 1920.[5]

Δ—Colorado River Aqueduct model pumps.[6]

PUMP EFFICIENCIES

Divergent or retarded flow has been examined by a number of investigators and an excellent account of modern knowledge with bibliography has been given by G. N. Patterson in *Aircraft Engineering*.[3]

[1] "Proportional Disc Losses of Pumps and Fans," THE ENGINEER, Vol. 169, 1940, page 574.

[2] As above, THE ENGINEER, Vol. 169, 1940, page 519.

[3] "Modern Diffuser Design," *Aircraft Engineering*, September, 1938, pages 267–273.

[4] "Proc.," I. Mech. E., 1932–33, page 625.

[5] "Hydraulic Turbines, with a Chapter on Centrifugal Pumps." McGraw-Hill. 1920.

[6] *Mechanical Engineering*, Vol. 60, 1938, page 295.

It is usual to state the loss of head in retarded flow in the form

$$\Delta h = \frac{k\,(V_1^2 - V_2^2)}{2g},$$

where V_1 and V_2 are the mean velocities at entrance and exit respectively. The value of k depends on the shape of cross section of the passages, on the angle of divergence, and appears to be almost independent of the Reynolds number. For straight rectangular channels the maximum efficiency of conversion $(1-k)$ occurs when the angle of divergence is about 10 deg. to 12 deg., and its value lies between 0·82 and 0·92. At greater and smaller angles than this the efficiency decreases rapidly.

Using these results and assuming a similar conversion efficiency in the impeller and diffuser, the writer arrives at the following approximate formula:

$$H_h = \frac{\text{hydraulic loss in impeller and diffuser}}{\text{hydraulic output}} = \frac{k}{1-k}\left[1-\phi^2\left\{1-\left(\frac{d_1}{d_2}\right)^2\right\}\right]$$

where

$\phi = u_2/\sqrt{2\,g\,h}$,
u_2 = peripheral speed of impeller,
d_1 = effective mean vane diameter at inlet,
d_2 = effective mean vane diameter at outlet.

It is necessary that both ϕ and d_1/d_2 shall increase as specific speed increases. An increase of ϕ decreases H_h, whereas an increase in d_1/d_2 increases it. The result is that H_h has a minimum value at an intermediate specific speed for pumps of similar type. For example, considering volute pumps and using the values

(1) $n_s=0\cdot07$ (non-dimensional units), ($N_s=1100$ in Imperial gallons per minute units), $\phi=0\cdot9$, $d_1/d_2=0\cdot4$, $k=0\cdot15$, then $H_h=0\cdot056$. Allowing 0·063 for disc friction (from previous letter), and 0·02 for leakage and bearing friction, the total loss is 0·139 and the efficiency $=1/1\cdot139=0\cdot88$.

(2) $n_s=0\cdot14$, ($N_s=2200$), $\phi=1\cdot05$, $d_1/d_2=0\cdot5$, $k=0\cdot15$, then $H_h=0\cdot031$. Allowing 0·03 for disc and 0·01 for leakage and bearing friction, the total loss $=0\cdot071$ and the efficiency 0·933.

(3) $n_s=0\cdot28$, ($N_s=4400$), $\phi=1\cdot25$, $d_1/d_2=0\cdot75$, $k=0\cdot15$, then $H_h=0\cdot055$. Allowing 0·015 for disc and 0·005 for leakage and bearing friction, the total loss $=0\cdot075$ and the efficiency 0·93.

The value of k was chosen so that the graph obtained would coincide roughly with the model pumps for the Colorado river aqueduct. The curves given by Sherwell and Pennington and by Daugherty in 1919 have also been compared with a curve based on the above equation and figures with $k=0\cdot4$. It will be noticed that there is remarkable similarity between the calculated curve and that obtained from test figures. It is to be predicted from the results that as the general pump efficiencies increase the improvement will be more marked in the high specific speed range. Discontinuities in curves over the whole range covered by turbine, volute, mixed flow and axial flow pumps are to be expected, since the relations between ϕ, d_1/d_2 and n_s will be different for the different types.

J. JENNINGS, B.Sc., A.M.I. Mech. E.
Birmingham, July 23rd.

THE PROCESS OF COMBUSTION IN INTERNAL COMBUSTION ENGINES

SIR,—In his article in THE ENGINEER of June 7th, 1940, pages 509–510, Professor David based a theory of flame propagation on certain "experimentally ascertained facts," which "present a difficult problem." But are all of the experimental observations that he used "experimental facts"? Professor David stated that when gases are ignited in a spherical explosion vessel there is no sensible rise of pressure until the flame has travelled at least one-fifth of the radius of the sphere, and this pre-pressure period cannot be influenced by turbulence, although the period up to the attainment of maximum pressure can be greatly affected. Reference to some closed vessel experiments carried out at the National Physical Laboratory nearly twenty years ago (*vide* Aeronautical Research Committee, Reports and Memoranda, No. 902) shows that the recorded effect of fan turbulence on the so-called "pre-pressure

period " was at least equal to that on the subsequent pressure rise period.

The term " pre-pressure period " is itself a misleading misnomer, for it is inconceivable that combustion of the type under consideration can make any progress without a rise of pressure, although, of course, the rise of pressure will be small—too small to be recorded by an indicator suitable for recording the full explosion pressure. By analysis of the rise of pressure subsequent to ignition it has been shown by Lewis and von Elbe (*Journal of Chemical Physics*, Vol. 2, pages 283–290, 1934) and by Fenning and Whiffin (" Phil. Trans.," Roy. Soc., Vol. 238, pages 149–228, 1939) that for the early stages of the flame travel the pressure rise must be very slow. For instance, on page 199 of the latter paper it is shown that, under the conditions postulated, the same pressure rise is produced by the first 20 per cent. of the flame travel as by the last 0·0107 per cent., and reference to the diagram given in that paper indicates that this rise is of the order of 0·1 per cent. Although

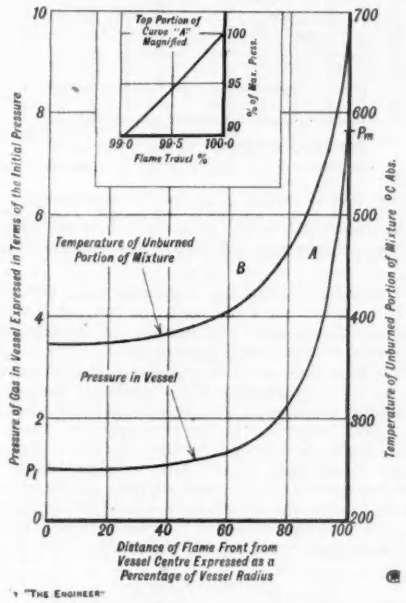


Diagram of Flame Travel

these figures were obtained by the summation of small increments, an approximate value can be obtained by a simple calculation. When the flame has travelled one-fifth of the radius of the sphere, the inflamed charge occupies one one-hundred and twenty-fifth of the whole volume and may have a density of, say, one-sixth that of the unburned charge. The proportion of

inflamed charge is therefore $\frac{1}{125} \times \frac{1}{6} = \frac{1}{750}$ of the whole

mass. Since it can be taken that the rise in pressure is roughly proportional to the mass of the charge burnt, the rise would be expected to be about one-seven-hundred and fiftieth of the total rise and hence its magnitude somewhat difficult to detect. There is no doubt that the pressure rise is there and has been building up continuously since the instant of passage of the spark. It is difficult to understand why Professor David should consider that the mode of flame propagation changes at the particular point at which a particular indicator is sensitive enough to record a small rise of pressure.

R. W. Fenning.
Teddington, July. A. C. Whiffin.

PRODUCTION PROBLEMS

Sir,—Now that the events on the Continent have altered not only the military, but the economic situation, one feels that we ought from an engineering angle at once to proceed to a great simplification of many of the jobs that are in hand in connection with the war effort. I will mention only two :—

(1) *New Factories.*—While it would be quite untrue to say that these factories are being built " regardless of cost," it is true that many of them, designed many months ago, are very large consumers of steel, wood and cement, all materials which are now very scarce. These factories have to take their place in the queue for supplies of steel and other materials, and the original completion dates cannot now be adhered to because these materials will not be forthcoming as anticipated.

In many cases a drastic survey of design should render simplification possible. Second-hand materials could be used, the design altered to allow for the use of cheaper alternative materials, *e.g.*, asbestos sheets instead of corrugated iron, brick *pavé* roads instead of concrete, &c. Best of all, in many cases factories not now required for luxury trades can be utilised instead of continuing with the building of the new factories.

(2) *Machine Tools and Other Machinery.*—Many of the functions that have to be performed in the production of arms by machine tools are relatively simple and could be achieved by a much simpler type of machine. Modern machine tools are complex masses of hardened and ground shafts, splined wheels, ball and roller bearings, and the like. In addition, they are now made in about ten to twenty different kinds of steels and alloys. All these things are very difficult to get and entail long delays as well as high costs.

The machine tool industry is already working to its fullest capacity and deliveries are reported to be in the region of two years. For many jobs nothing but a standard machine tool would do, but on other jobs as previously mentioned a much simpler machine would be equally satisfactory, although it would take more labour. It does not look as though labour is going to be the bottle neck, at least for a long time to come, and we should at once step up our output if we could get more machines. It should be possible to design simple spindles running in plain bearings, which would perform many of the single-purpose jobs required on Bren guns, rifles, aeroplane parts and the like. The operations I have in mind are simple milling, drilling, slotting, turning, &c.

In the last war it was possible for many firms to augment the supply of machine tools, cartridge presses, and the like, because these machines were relatively simple. Now they are so complicated that only firms specially laid out with very elaborate equipment can do this work. If designs could be simplified, and there is no reason why they should not be for many operations, then hundreds of firms up and down the country with ordinary workshop maintenance plant could turn to and produce very useful equipment.

The general purpose of this letter is to suggest that under our altered circumstances of shortage of steel, shortage of aluminium, &c., and the necessity for an immediate increase in the output of such things as Bren guns, rifles, &c., we should immediately look at the two problems :—

(1) More speedy provision of factory sites by the simplification in design of factories, the use of alternative materials, or the use of already existing factory facilities.

(2) That we should examine all the operations required to be performed by mass production of arms and other equipment, and see if many of these operations could not be done by a very much more simple type of machine, capable of being produced by almost any engineering shop in the country.

William N. Hallett, M.I. Mech. E.,
Chief Engineer, Cadbury Bros., Ltd.
Bournville, July 24th.

GLASS FIBRE ELECTRICAL INSULATION

Sir,—May I be permitted to offer some comments on the article by Dr. R. Quarendon, in The Engineer of June 14th, page 538 ? Glass fibre materials, such as tapes and cloths, are like any other woven materials, in that they have holes between the threads. It is well known that unless these holes are sealed with varnish the insulation of conductors is not good and if moisture is present breakdown is likely to occur through short-circuits. Although the glass fibres may be non-hygroscopic, moisture readily condenses on their surface and a glass insulated motor, without proper varnish protection, will fail just as readily as any other motor.

It seems fairly clear that the motor referred to in the article was insulated with an ordinary type of varnish, *i.e.*, one used for temperatures up to, say, 100 deg. Cent. If such a varnish is taken up to 200 deg. Cent. or more, it quickly loses its moisture-resisting properties and becomes more or less like a powder adhering lightly to the glass. A motor which has been subjected for a period to temperatures much higher than the impregnant will stand will readily fail in the presence of moisture whether the insulation be glass or cotton.

There is a tendency, too, to use glass insulation in conjunction with vegetable insulations, such as cotton and low-temperature varnishes. It is difficult to understand why an expensive material such as glass fibre should be used in such cases. Varnishes are now coming on the market which look promising for service at temperatures up to 200 deg. Cent. By using glass insulation, asbestos or glass insulated conductors, mica and high-temperature varnishes, it will be possible to design machines that represent a real advance on present-day practice, and this, I submit, is the direction in which electrical design should move. Real progress cannot be made by mixing the new with the old.

R. H. Robinson, B.Eng., A.M.I.E.E.
G.E.C., Ltd., Witton, July 25th.

Sixty Years Ago

The S.S. " Anthracite "

The faith which Loftus Perkins had in the use of high pressures and high ratios of expansion in steam engines was not shared by many of his contemporaries. To convince the doubters he installed his engines and boilers in a yacht, the " Wanderer," but the engines broke down, caused much trouble and were finally condemned and removed. Not to be beaten, he equipped a second small vessel, the " Loftus Perkins," with his system of engines and boilers, but after a few months of service, during which more time, it was said, was spent in making repairs than in running trips, the engines were sent to the scrap heap. Still undismayed, he fitted his system to a 70-ton yacht, the " Anthracite," and sent her forth to cross the Atlantic. To-day we can not only acknowledge him as a pioneer but also express our admiration of the boldness with which in the face of two defeats he risked a third on a perilous adventure. Yet the experiment succeeded. After coaling at Falmouth, the little steamer passed the Manacles on the evening of June 2nd, 1880, and arrived at St. John, New Brunswick, on June 21st. The weather during the crossing had been unusually boisterous, but the captain and officers were abundantly satisfied with the results of the voyage. Subsequently the " Anthracite " proceeded to New York, where she was made the subject of official inspection and test. Meanwhile scepticism continued to prevail in this country, in spite of the success of the trip. In our issue of July 30th, 1880, we devoted a leading article to the Perkins system in the light of a report made by Mr. (Sir F.) Bramwell on some trials of the " Anthracite's " engines made before she put to sea. The engines consisted of a single-acting high-pressure, a single-acting intermediate and a double-acting low-pressure cylinder inverted over a crankshaft with two cranks at right angles. The first and second cylinders were in line. On the downstroke steam was admitted above the piston of the first cylinder and after being exhausted was admitted below the piston of the second cylinder during the upstroke. Thereafter it was exhausted into a receiver, from which the low-pressure cylinder was supplied. The engine expanded the steam thirty-two times. The boiler generated steam at 360 lb., but the pressure was reduced to 180 lb. before the steam was admitted to the high-pressure cylinder. In our leading article we enrolled ourselves among the ranks of the sceptics. Mr. Bramwell's report, we said, was very incomplete. Over a period of eleven hours, it recorded, the engine developed an average indicated horsepower of 80·55 with an average consumption of 1·7 lb. of coal per I.H.P. hour. We criticised the trials on the ground that the coal used, Nixon's navigation hand-picked lumps, was probably the best coal in the world, that even so the economy was little, if any, better than that of an ordinary Atlantic cargo steamer burning ordinary North Country coal, that if Mr. Perkins believed in the virtue of high pressure, he ought to use it and not halve the boiler pressure before admitting the steam to the cylinders, and that with a ratio of expansion of 32 to 1 unless the steam were very highly superheated the condensation in the cylinders could not be otherwise than enormous.

Wireless Mechanics for the R.A.F.—Rapid expansion of the Royal Air Force has resulted in an increased demand for men able to maintain radio appliances. This job is one of vital importance and fully qualified mechanics with a good theoretical and sound practical knowledge of radio are urgently required. No experience of Morse code is necessary. The appeal for volunteers is addressed to men between the ages of eighteen and fifty on the servicing side of the radio industry, but those already employed on radio-instrument production or other work directly connected with the war effort are not eligible. Wireless engineers, testers, repairers, radio service men and wireless mechanics who are not affected by the proviso are asked to offer their services immediately.

American Pig Iron Production.—The production of pig iron in 1939, exclusive of ferro-alloys, was 31,075,914 gross tons, an increase of 67 per cent. over 1938, according to the Bureau of Mines, United States Department of the Interior. Of the 1939 total, 31,031,973 tons were made with coke as fuel and 43,941 tons with charcoal. The production of pig iron in 1939 required 51,160,340 gross tons of domestic iron and manganiferous iron ores, 2,262,043 tons of foreign iron and manganiferous iron ores, 3,735,132 tons of mill cinder and roll scale, 721,286 tons of purchased scrap, 1,004,565 tons of home scrap, and 1,737,000 tons of flue dust. Thus, an average of 1·862 tons of metalliferous materials, exclusive of home scrap and flue dust, were consumed per ton of pig iron made in 1939, compared with 1·880 tons in 1938. The average consumption of ore per ton of pig made was 1·719 tons in 1939, compared with 1·742 tons in 1938.

The Combustion Gas Turbine*

By J. T. RETTALIATA†

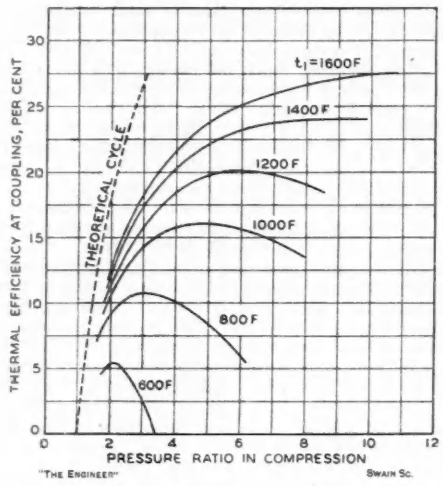
(*Continued from page 64, July 26th*)

THERMAL EFFICIENCY

FOR any given turbine inlet temperature there is one compressor pressure ratio for which the thermal efficien y of the unit will be maximum, as shown in Fig. 6.

The sensitivity of the cycle to temperature is effectively displayed by a doubling of thermal efficiency when the temperature is increased from 600 deg. to 800 deg. Fah.

Another reason for the gas turbine remaining in the background during its long development period may be had from the lower temperature curves in Fig. 6. The poor thermal efficiencies shown by these



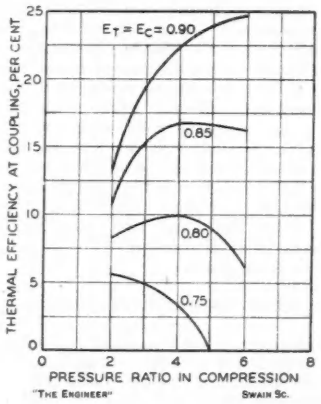
(t_1 = turbine inlet temperature)

FIG. 6—*Thermal Efficiency as a Function of Pressure Ratio for Various Turbine Inlet Temperatures—Non-regenerative Cycle*

curves must be decreased still further when the lower efficiencies of the earlier turbines and compressors are taken into account. Small wonder then if the developers of the early gas turbines made slow progress when such limited temperatures were imposed by inferior materials.

The highest normal operating temperature of any of the gas turbine units built to date has been 1000 deg. Fah. The higher temperature curves are exhibited to demonstrate the possibilities of projected development. Research on blading materials, however, indicates that increased temperatures may be considered as practical in the not too distant future.

Reference to Fig. 4 (*ante*) will reveal that the turbine



(E_T = turbine efficiency and E_C = compressor efficiency)

FIG. 7—*Thermal Efficiency as a Function of Pressure Ratio for Various Efficiencies of Turbine and Compressor—Non-regenerative Cycle*

exhaust gas is discharged at 612 deg. Fah. into the atmosphere. Such degradation of energy naturally hinders economical operation. One of the various methods by which the thermal efficiency of the gas cycle may be improved is by the use of a heat exchanger. In this manner the exhaust gas from the turbine may be utilised in raising the temperature of the air discharged from the compressor.

The introduction of a heat exchanger must be undertaken with caution, however, as an excessive pressure drop through it may easily nullify any increase in efficiency that could otherwise be realised. Nevertheless, when properly designed, improved performance is readily attainable.

By the addition of a heat exchanger having a size of about 11 square feet per excess horsepower, the thermal efficiency of a unit operating with a turbine admission temperature of 1000 deg. Fah. may be increased approximately 50 per cent.

Thermal efficiency as a function of pressure ratio for various efficiencies of turbine and compressor is shown in Fig. 7. The importance of high turbine and compressor efficiencies is strikingly brought out, for increasing these efficiencies from 0·75 to 0·90, a 20 per cent. change, results in a 400 per cent. increase in maximum thermal efficiency obtainable.

The curves are all based on a turbine inlet temperature of 1000 deg. Fah. Their trend will naturally be upward when future materials warrant safe operation at higher temperatures.

It will be noticed that the peaks of the various curves occur at different values of pressure ratio, thus signifying the dependence of maximum thermal efficiency upon the correct association of pressure ratio with combined efficiency of turbine and compressor.

Here again is emphasised the need of a highly efficient turbine and compressor. Only because the modern gas turbine axial compressor unit possesses this necessary high efficiency is the cycle commercially practicable to-day.

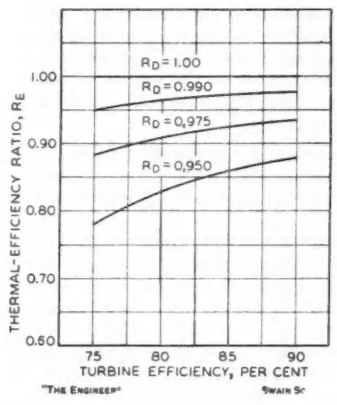
The effect on thermal efficiency of a drop in pressure from the compressor discharge to the turbine inlet for various turbine efficiencies is shown in Fig. 8. No regenerator is included in the cycle and the turbine inlet temperature is assumed to be 1000 deg. Fah.

The pressure drop is expressed as a ratio of turbine inlet pressure to compressor discharge pressure. Similarly, the effect of this pressure drop is signified by the ordinate scale showing the ratio of the thermal efficiency obtainable with a pressure drop to that which would exist in a cycle without a drop in pressure.

The curves indicate the effect of pressure drop on thermal efficiency to be more pronounced at lower turbine efficiencies. Furthermore, the slopes of the curves increase with increasing pressure drops.

Selecting values from the curves shows that a 5 per cent. drop in pressure with a turbine efficiency of 80 per cent. causes a 17 per cent. decrease in thermal efficiency.

Fig. 8 quite effectively demonstrates the importance



[R_D = (turbine inlet pressure)/(compressor discharge pressure); R_E = (thermal efficiency with pressure drop)/(thermal efficiency without pressure drop)]

FIG. 8—*Effect of Pressure Drop on Thermal Efficiency—Non-regenerative Cycle*

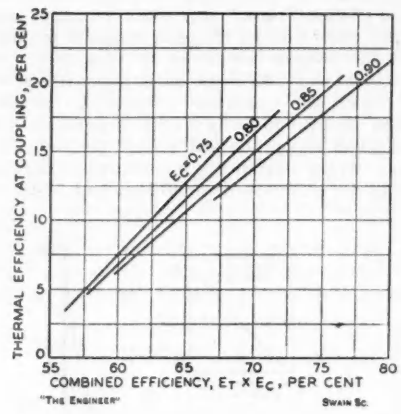
of a design free from any serious restrictions to flow. A study of the curves will show how the use of a heat exchanger with a prohibitive pressure drop would have a deleterious effect on the thermal efficiency possible of attainment with a properly designed regenerator.

In certain chemical processes gas turbine axial compressor units are used for supercharging. High-temperature gas returned from the process is furnished the turbine for the development of power. In some of these instances the pressure drop in the process is high enough to reduce to zero the excess power which would otherwise be obtainable with a moderate drop in pressure. Such inefficiency is only tolerated, however, in these special cases where the primary concern is the delivery of air and not the production of power.

Thermal efficiency as a function of the combined efficiency of the turbine and compressor for various compressor efficiencies is shown in Fig. 9. The curves are computed on basis of a pressure ratio of four and a turbine admission temperature of 1000 deg. Fah.

One important feature to recognise is that lower compressor efficiencies yield higher thermal efficiencies for any given combined efficiency. This results from the turbine handling larger quantities of energy than the compressor. Therefore, if the level of combined efficiency is fixed it is more advantageous to favour the turbine than the compressor. For instance, an assumed combined efficiency of 64 per cent. could be obtained by turbine and compressor efficiencies of 80 per cent. each, but higher thermal efficiency would result from an arrangement having the same combined efficiency yet consisting of turbine and compressor efficiencies of 82 and 78 per cent., respectively.

An examination of Fig. 9 will reveal why the axial type of compressor was selected to operate in conjunction with the gas turbine instead of the centrifugal type. In general, in the range of pressures and volumes in which gas turbine units operate, the highest adiabatic efficiency likely to be obtained with a multi-stage centrifugal compressor is about 75 per cent., whereas for the axial compressor it is approximately 83 per cent. or slightly higher. Using these figures and assuming a turbine efficiency of 85 per cent., combined efficiencies of 63·8 and 70·5 per cent. can be obtained with multi-stage centrifugal and axial compressors, respectively. Therefore the maximum thermal efficiency that could normally be realised



(E_T = turbine efficiency; E_C = compressor efficiency)

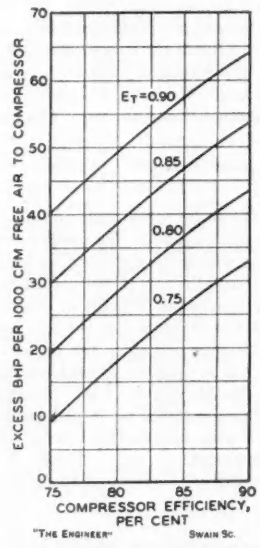
FIG. 9—*Thermal Efficiency as a Function of Combined Efficiency for Various Compressor Efficiencies—Non-regenerative Cycle*

when using a centrifugal compressor in the cycle would be about 12·5 per cent., as compared with a value of 16 per cent., an increase of 28 per cent., obtainable with an axial compressor.

Thus the early inventor endeavouring to achieve success when employing the centrifugal compressor was doubly penalised; first, by the natural limitations of a cycle operating under temperatures not sufficiently high; and second, by the inherent inefficiency of the compressor itself. His colleague using the axial compressor fared but slightly better, for he laboured under the same temperature restrictions and his type of compressor did not reach its pre ent efficient state until comparatively recently.

EXCESS POWER

The excess power of a unit as a function of compressor efficiency for various turbine efficiencies is shown in Fig. 10. The curves are based on a cycle



(E_T = turbine efficiency)

FIG. 10—*Excess Power as a Function of Compressor and Turbine Efficiencies*

with no regenerator and a turbine admission temperature of 1000 deg. Fah.

A manifestation of the importance of high turbine and compressor efficiencies is presented by the curves. A 20 per cent. increase in a turbine efficiency of 75 per cent. entails a 300 per cent. increase in excess power with a compressor efficiency of 75 per cent.

At a given turbine efficiency the excess power increases approximately linearly with compressor efficiency.

By reason of its molecular weight and isentropic exponent (when in superheated vapour state) being less than that of air, water injected into the combustion chamber will increase the excess power developed by a given size of gas turbine axial compressor unit. Such a procedure, while augmenting the output of the unit, is nevertheless an inefficient practice owing to the latent heat of vaporisation loss

* Paper presented at the 1940 Conference of the Oil and Gas Power Division of the American Society of Mechanical Engineers.

† Steam Turbine Department, Allis-Chalmers Manufacturing Company.

at the turbine exhaust. If indulged in extensively the concomitant reduction in overall thermal efficiency may prove prohibitive.

The effect of intake air temperature on the power delivered by a unit is shown in Fig. 11. As may be seen from the curve, an increase in temperature decreases materially the output of a given unit. On the other hand, a unit designed for normal operation with an intake air temperature of 60 deg. Fah. will develop approximately 50 per cent. more than rated

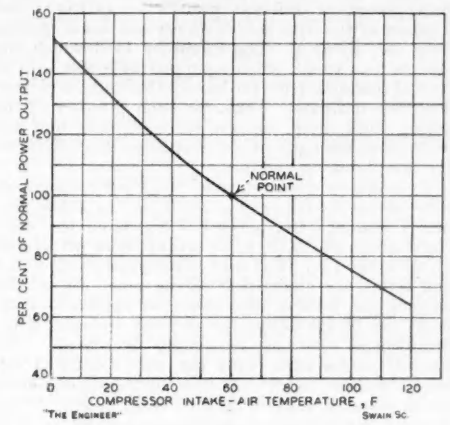


FIG. 11—*Effect of Intake Air Temperature on Excess Power*

power when the air temperature is reduced to 0 deg. Fah.

The output of a unit as affected by altitude is illustrated by the curve in Fig. 12. Upon examination it can be seen that high altitudes have an adverse effect on the power obtainable.

If the unfavourable effect of temperature and altitude is of a temporary nature, as may be the case, for instance, in locomotive or marine applications, it may be remedied by water injection. As mentioned before, however, such practice should be

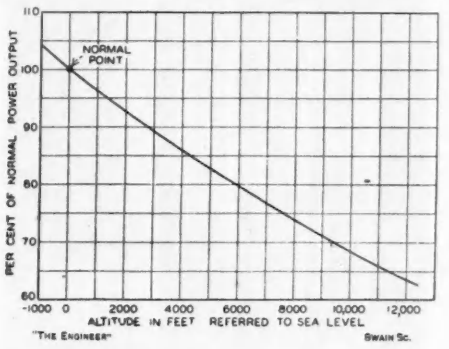


FIG. 12—*Effect of Altitude on Excess Power*

resorted to only when absolutely necessary because of the ensuing decreased economy of operation at such periods.

APPLICATIONS

At the present time the principal commercial application of the gas turbine axial compressor unit in the United States has been in oil refineries. Air discharged from the compressor is used in a process and the resulting high-temperature gases are expanded in the turbine, producing power, the excess of which is supplied to a generator. In this arrangement no combustion chamber is required as the process itself acts in this capacity.

Many gas turbine axial compressor units operate as superchargers in the Velox boiler, developed by Brown-Boveri, where the boiler exhaust gases drive the turbine.

A 4000-kW unit has been installed in an emergency standby power station in the city of Neuchâtel, Switzerland. Its simplicity and independence of water facilities ideally adapt the gas turbine to this class of service. Recently published tests, conducted by Stodola, indicate a coupling thermal efficiency, based on lower heating value of fuel, of 18·04 per cent. for this unit when operating on a non-regenerative cycle with a turbine inlet temperature of 1000 deg. Fah. This is the first unit built for the primary purpose of producing power.

A 2200 H.P. gas turbine locomotive, with electrical transmission, is being built by Brown-Boveri for Swiss Federal Railways.

In this country Allis-Chalmers, licensee of Brown-Boveri, is engaged in an engineering study of the possibilities of the gas turbine as a drive for locomotives of larger output. Both electrical and mechanical transmissions are being studied as well as the merits of the hydraulic coupling. One mechanical drive locomotive is rated at 5000 H.P. at the power turbines. At an efficiency of 90 per cent. this corresponds to 4500 H.P. at the axle.

The overall length is approximately 87ft., the height over the cab is 15ft. and the width 10ft. 4in. The total operating weight is about 500,000 lb., or 112 lb. per horsepower at the axle. There are two driving axles on each truck, the drivers being 52in. diameter and the total weight on them 280,000 lb. The wheel base is 78ft., which permits turning on an 80ft. turntable, so the cab and transmissions are designed for one-way operation.

The power plant has been divided into two units of 2500 H.P. each, being lighter and better adapted to uniformly distribute the weight along the frame than a single 5000 H.P. unit, and also permitting a lower and better arrangement of the various elements, especially the transmissions.

The use of separate power turbines improves the performance as the compressor and its driving turbine can operate independently at the best speed for the conditions regardless of the speed of the locomotive and the power turbine.

The speed and power of the locomotive are controlled by a combination of manual and governor control of the fuel burned in the combustion chamber and by throttling the power turbine.

Numerous other natural and favourable applications of the gas turbine axial compressor unit will develop from time to time and probably include marine propulsion, blast-furnace plants, wind tunnels, special power plants and other special applications.

Water-Softening Treatment by Upward-Flow

IN many parts of the United States the water supply for domestic purposes is of such degree of hardness as to be objectionable or inconvenient, and within recent years there has been much activity in the study of water softening treatment and the installation of plants for such treatment. The saving in cost of soap alone would often justify the softening as an economic measure, and many towns of the smaller class, as well as large cities, are considering or adopting this treatment as a matter of both economy and public convenience.

Among the various methods of applying the chemical treatment for water softening is the upward-flow method, and a recent report by Mr. H. A. Spafford, Assistant Sanitary Engineer of the Illinois State Department of Public Health, predicts that this comparatively new system will play an important

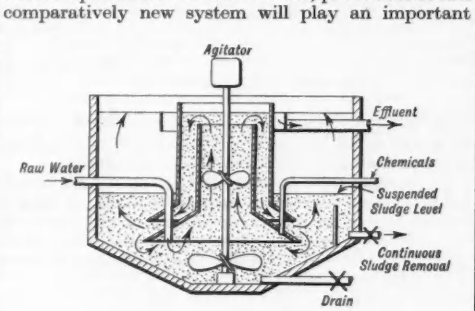


FIG. 1
ACCELERATOR

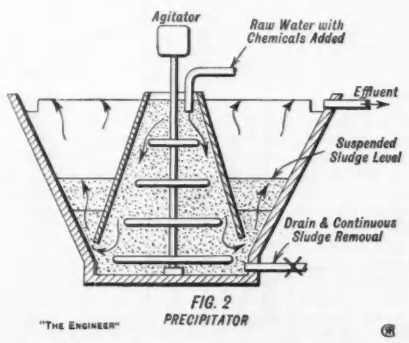


FIG. 2
PRECIPITATOR

"THE ENGINEER"

FIGS. 1 AND 2—UPWARD-FLOW WATER SOFTENERS

part in the development and improvement of water supplies of varying degrees of hardness. Two softening systems based on the upward-flow principle, and known respectively as the Accelerator and Precipitator systems, are described in this report.

In the Accelerator, shown diagrammatically in Fig. 1, a square or circular basin, with vertical sides and hopper-shaped bottom, has in the centre two concentric metal tubes, each with a funnel-shaped or flaring skirt at the bottom. A propeller type of agitator with vertical shaft revolves in the inner tube. In its operation, the raw or aerated water enters near the bottom of the basin and under the lower skirt on the inner tube. Chemicals are introduced through pipes opposite the water inlet. The water, mixing with previously precipitated sludge and the chemicals, is forced upward through the inner tube by the agitator, and then passes down through the annular space between the tubes, issuing between the skirts into the basin. A large portion of sludge and water is drawn back under the lower skirt into the mixing zone and is thus re-circulated. The bottom of the basin contains a sludge blanket several feet thick, held in suspension by the action of the agitator. The treated water, having been mixed thoroughly with the chemicals and brought into intimate contact with existing sludge particles, issues vertically from the blanket in a clarified condition and flows out at the top of the basin, ready for recarbonation or filtration, as may be required.

The Precipitator, shown in similar diagrammatic form in Fig. 2, has a circular concrete basin in the shape of a frustrated cone having its larger diameter at the top, so that the basin has a flat bottom and sloping sides. At the middle is a smaller frustrated cone, having its larger diameter at the bottom. This cone is made usually of steel plate, but in some large plants it is of concrete. An agitator with vertical shaft and horizontal arms revolves in the centre of the inner and smaller cone. The raw water and chemicals may be introduced directly, but separately, into the basin or may be mixed in a separate mixing basin or dosing well before passing into the main basin. In any case the water has a downward spiral flow in the central cone, where intimate contact of water, chemicals and existing sludge particles is effected. At the bottom the flow is reversed, and the water passes upward through the annular space between the two cones.

As in the other apparatus, a blanket of sludge in suspension, several feet thick, is maintained in the lower part of the main basin by the force of agitation and velocity of flow. Triangular baffles placed radially in the space between the two cones prevents transfer of circular motion from the agitator to the clarification compartment or outer portion of the basin. Treated water passes up through the sludge blanket, issuing with low turbidity, and overflows at a circular weir around the top of the basin, being then in condition for recarbonation or filtration. In some cases the basin is square, so that both the basin and the central structure are in the form of frustrated pyramids.

In both these systems there is a blanket of sludge in suspension, the treated water is contacted intimately with sludge particles previously precipitated, and clarification is effected by mechanical means, closely approaching filtration through the blanket, rather than by sedimentation. Two basic principles are employed. In the first place, the water treated with chemicals, and thus super-saturated with the elements producing hardness, is brought into intimate contact with the particles of previously precipitated sludge, thus exposing the water to a very large area of crystal surface and so tending to rapid and complete precipitation of the objectionable minerals. In the second place, clarification is effected by mechanical means which borders on filtration or straining of the water as it passes through the sludge blanket. The small and newly formed particles of precipitate are trapped by the larger and heavier sludge particles, which results in rapid production of an effluent of low turbidity without resort to plain sedimentation.

The value of contact with previously formed precipitate in lime softening of water has been recognised for some years, and sludge return has been practised in some treatment plants of conventional design. But in this earlier work the amount of sludge returned has usually been limited by the mixing and settling facilities available, so that the optimum contact with previously formed crystal surfaces was difficult or impossible. In fact, beyond a certain point this sludge return has often resulted in clarification difficulties. And with water containing organic material the sludge frequently became fouled and thus imparted objectionable tastes and odours to the water. The upward-flow method was developed as a means of obtaining the maximum benefit from sludge contact, without the limitations here noted.

Sludge produced in the apparatus above described contains particles considerably larger than those obtained with ordinary mixing and settling. It has a gritty feeling when rubbed between the fingers or on a glass plate. When the water is in intimate contact with the sludge the calcium carbonate is deposited on these larger particles. Deposition of carbonates by crystallisation on existing particles, resulting in growth of crystals in size and weight, is similar to the increase in size of sand of filters receiving lime-softened water, but the action is much more rapid. Sludge composed entirely of such large particles is not desirable, as it is not so effective and the agitation equipment may be overloaded if the size grows indefinitely. The maximum in crystal surface exposure is obtained with very small particles, but if they are too small the efficiency of clarification decreases. The optimum size of particles is that minimum size which produces good clarification. In any individual plant the sludge character and particle size are controlled by the speed of agitation, chemical dosage and amount of sludge removal, together with the character of the raw water and the coagulant used.

Both of the upward-flow processes described employ continuous sludge removal, and sludge concentration must be maintained at the proper point to effect optimum results. The proportion of solids in the mixture of sludge and water varies from 0·5 to 2 per cent. by weight, according to local conditions, but heavier concentrations have been used. As sludge

accumulates during operation the surplus must be removed, but with sludge kept in suspension by the agitation action the entire mass is fluid during operation. This makes it easy to arrange continuous and uniform sludge removal, which is accomplished without the aid of devices for dragging or scraping the bottom of the basin. Gravity withdrawal of sludge is effected by the head or pressure in the basin.

An outstanding feature of the upward-flow process is the extremely high rate of operation, while producing effluent of remarkably low turbidity. The turbidity is consistently under 10 parts per million, while figures of 5 to 3 parts are frequent. In basins designed for both mixing and clarifying the total retention period has been reduced to 35 or 45 minutes, under favourable conditions, and plants have been designed for a maximum period of 75 down to 55 minutes in regular operation. At waterworks plants having single upward-flow basins, or basins operated in parallel, these retention periods cover the total time required, from the entrance of the raw water until its discharge in treated and clarified condition.

These very short retention periods are in contrast to the periods of several hours which are considered good practice in plants employing plain sedimentation. In such plants 2½ hours is about the minimum for combined mixing and settling, while a minimum of 2½ to 4 hours for settling alone is approved by many authorities. In upward-flow treatment, however, the operation is rated usually in gallons per minute per square foot of surface area, rather than by time of retention. While the earlier plants were designed for a rate of ½ gallon to 1 gallon per minute per square foot, experience showed that this might be increased, and more recent plants are designed for rates of 1½ to 2½ gallons. These rates are closely in line with those for rapid sand filters, which are rated on the same basis. With the high rates of treatment and the short retention periods there is a corresponding reduction in size of basin for a given capacity, with consequent less space required and economy in construction for plants of the upward-flow type.

Cooling Quenching Oil

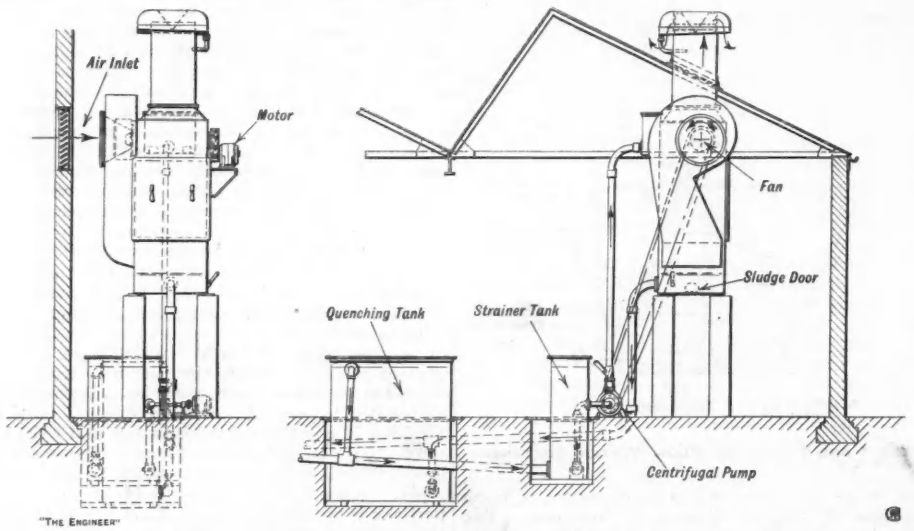
In our issue of June 28th we reprinted from *Iron Age* a description of an American cooling plant for quenching oil. The plant was "home-made" in the sense that it was constructed by the operators to suit local conditions, and it is probable that its efficiency is lower than that of expressly designed plants. But it is effective, if not highly efficient, and that is always something.

By contrast with it we give an outline drawing of a "proprietary" cooler of a type extensively used, made by Heenan and Froude, Ltd., with some notes on British practice.

Here, when water must be used as the cooling medium, the general practice is to avoid the American recommendation of a water-cooled coil in a tank, and to use instead a tubular heat exchanger, through which the oil is pumped. Such units can be designed for optimum oil and water velocities, thus reducing their cooling surface and cost to the minimum. When the oil is to be cooled by air, proprietary oil coolers are available which are not only long past the experimental stage, but which are offered under a guarantee which takes into account the total heat to be extracted, expressed either as B.Th.U. per hour removed from the oil or as the weight of steel quenched per hour at stated temperatures. The cooler itself employs forced air draught, the internal cooling elements consisting of metal surfaces on which oil and air come into intimate contact. The efficiency of these surfaces is high, and the space taken up by the unit is therefore small relative to the duty. Incidentally the cooler can readily be placed outside the heat treatment shop in the open, when the lay-out necessitates this.

As regards convenience of operation and simplicity of lay-out, it will be noted from our drawing that forced circulation of the oil is retained, but that this is obtained by the use of a single pumping set and a single pump tank, whereas the American lay-out, shown in our issue of June 28th, involves the duplication of these items.

The pump tank is provided with removable strainers to trap the loose scale which flakes off the steel while quenching; this strainer is of the simple basket type, except where the rate of flow would involve too heavy a basket for easy removal, and in such cases gate type strainers are used. The latter type is also employed where several quenching tanks are served by a single strainer tank. It will be seen that this lay-out avoids the possibility of two pumps working at unequal rates of flow, thus causing overflowing at some points with starvation at others.



Plant for Cooling Quenching Oil

Turbine-Blade Fatigue Testing*

By R. P. KROON†

In former times the location and size of lashing wires of steam turbine blading were fixed by more or less arbitrary rules. As a result, it often occurred that the material was not utilised properly. For example, in a segment with two lashing wires, the stresses in the lower wire might be several times as high as the stresses in the upper wire. Thus the lower wire would fail long before the strength of the other wire, or the blade itself, would be endangered.

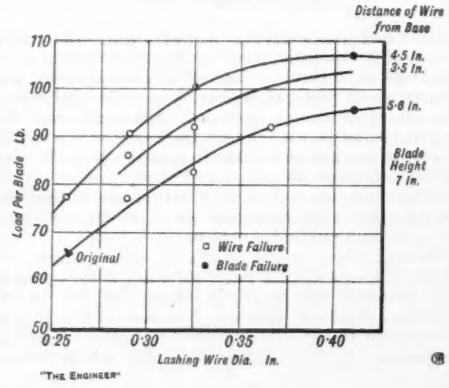


Fig. 1—*Influence of Location and Size of Lashing Wire on Mechanical Strength of Blade Group*

In an ideal arrangement all wires should be loaded with the same factor of safety; that is, it should require the same amount of overload on the blade to produce failure in each wire. Also, the blade should be stressed about the same amount at each wire joint.

It appears to be a good rule to make the construction such that failure in the wires will occur before the blade itself fails. Any overload will then reveal itself by cracks in the wires rather than by the loss of blades.

Since the exact amount of stress concentration around the wire sections and at the root cannot be evaluated by calculation, the best method to arrive at the strongest possible combination is to combine fatigue test and analysis. Such work is now being carried out, and is resulting in new standard arrangements with superior strength.

Typical of the results of this work is a plot shown in Fig. 1. The blades under consideration are 1in. wide and 7in. high. Assuming that one wants to use a single lashing wire to interconnect the blades, the problem then becomes, how to choose the size and location of the wire to achieve maximum strength for this blading.

Fatigue tests were made with various-size lashing wires placed in different positions. In Fig. 1 the diameter of the wire used for a certain test is plotted along the abscissa. The vibratory load which the segment can stand, when equipped with this wire at a certain distance from the base of the blade, is plotted along the ordinate. Thus, for each position of the lashing wire, there exists a curve showing how the mechanical strength of the structure depends upon the wire diameter chosen.

According to the traditional rules previously used, these blades would have a No. 2 size (0·257in. diameter) lashing wire, located 5·6in. from the base. The diagram shows that this arrangement withstands a load of 65·7 lb. The wire is too small, and it fails long before the blade itself carries much stress. By bringing the lashing wire closer to the base of the blade and by increasing its size, the strength of the arrangement can be materially increased. The diagram shows that, with the wire located 4·5in. from the base, a No. 1 wire (0·289in. diameter) would stand a load of 91 lb. With a No. 0 wire (0·325in. diameter) the segment would stand 101·3 lb. and with a No. 000 wire (0·410in. diameter) the segment would carry 106·8 lb. These loads are between 37 and 62 per cent. higher than that of the original arrangement.

At this location and with a No. 1 wire, all failures occurred in the wire. With a No. 0 wire at the same location, the majority of the test specimens failed in the wire, but some cracked through the blade. With a No. 000 wire all failures took place in the blades. It becomes a matter of policy whether one prefers the arrangement with the highest mechanical strength which would fail in the blade, or the somewhat weaker arrangement in which fractures would occur in the wire.

Fig. 2—*Pneumatic Vibrator Fatiguing Group of Reaction Blades*

The foregoing problem is of a type which often occurs in blade fatigue testing. Frequently, it is required to test a number of slightly different arrangements and to pick out the best combination. The question then is, How should the tests be made and how should the results be rated?

Devices Used to Fatigue Turbine Blades

In the course of time a number of devices have been employed to fatigue turbine blades. These include rotating devices with excentrics deflecting the blades, various crank devices, and magnet apparatus. At the present time our apparatus is of four distinct types, each filling a particular need.

To study the various modes of vibration and to fatigue blade assemblies at their natural frequency, a variable-frequency instrument was needed.

An electro-magnetic vibrator, developed by J. G. Baker, of the Westinghouse Company, has been in use since 1932, and has proved itself to be a versatile instrument, not only for blade research, but also for the study of vibrations in gears, turbine dis s, blower casings, and the like. Its output is strong enough to vibrate and break an entire segment of blades, 38in. long. The pulsating force is obtained by sending alternating current of the desired frequency through a coil which is movable in the field of a strong direct-current magnet. The coil is connected to the specimens by a slender rod. The variable-frequency

* The American Society of Mechanical Engineers, June, 1940. Abstract.

† Manager, Experimental Division, Westinghouse Electric and Manufacturing Company, South Philadephia, Pa.

alternating current is produced in a small oscillator and stepped up in a 500-watt amplifier.

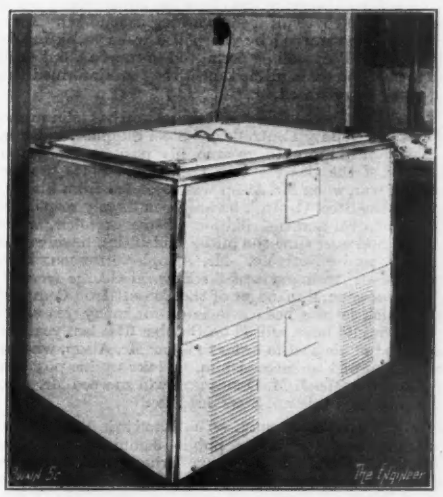
The attachment of a coil to the vibrating specimen presents some disadvantages. Unless the specimens are large, the weight of the coil is annoying, since it influences both the natural frequency and the stress distribution in the specimens. When one wishes to explore short stiff specimens, such as impulse blades, it is found that the acceleration of the coil is so high that its own strength is jeopardised.

To avoid this difficulty, apparatus was developed which did not require attachments to the vibrating specimens. The pneumatic vibrator,† Fig. 2, consists of a nozzle A which has the characteristic that it will feed energy into the vibrating system by means of pressure oscillations on the small plate B rigidly attached to the vibrating assembly. The resulting vibration is "self-induced," it takes place automatically at a natural frequency of the specimens, and no tuning is involved. The amplitude of vibration is controlled by the pressure before the nozzle.

This type of apparatus is quite powerful and good for extremely high frequencies. It has another advantage ; it makes possible the measurement of damping in the vibrating system in the course of a regular fatigue test. By suitable calibration, the energy output of the nozzle can be determined for a given setting and for a given pressure drop across the nozzle with the proper frequency. Thus, at any time during the test the amount of energy fed into the vibrating system, which must equal the amount dissipated by damping, can readily be determined.

Refrigeration for Duralumin Rivets

The use of duralumin, especially for aircraft production, is becoming increasingly widespread. All processes which tend to improve the facility of handling this alloy therefore are receiving much attention. Among those which have most recently been developed is the use of refrigeration for retarding the age hardening of rivets until they have been



Refrigerating Cabinet for Duralumin Rivets

riveted in place. It has been found that if rivets are stored at a temperature of about —10 deg. Fah. after heat treatment and quenching, they maintain their usable state for an extended period, and therefore require normalising at less frequent intervals than is otherwise necessary.

Among the manufacturers of refrigeration equipment, Coldair, Ltd., an associated company of the General Electric Company, Ltd., has been active in this field.

The cabinets which are used for the purpose are designed to facilitate rapid loading and unloading of the low-temperature compartment with the minimum rise of temperature. Arrangements are made to maintain an internal temperature of —10 deg. to —15 deg. Fah., with an ambient temperature of 80 deg. Fah. The cabinets are constructed from heavy gauge material. The capacity of a typical cabinet, such as that illustrated, is 2·9 cubic feet and the galvanised steel storage compartment which measures 22in. by 10¾in. by 21¼in. deep holds 500 lb. of rivets at a filling. Overall dimensions are 4ft. 4in. long by 2ft. 1in. wide by 2ft. 8in. high, and the general finish white or black enamel, with silver finished steel frame.

The specification includes 4in. compressed cork insulation, galvanised mild steel working top, thermostatic temperature control, and dial thermometer. The condensing unit comprises a standard ½ H.P. twin-cylinder compressor and ½in. solid drawn copper cooling coils.

† An invention of Dr. H. W. Emmons, formerly of the Westinghouse Company, now Assistant Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. It appears that similar apparatus has been used before (see "High-frequency Fatigue," by C. F. Jenkin and G. D. Lehmann, "Proceedings" of the Royal Society of London, Series A, Vol. 125, 1929, pages 83–119).

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The American Market

Whilst Great Britain is drawing so much of her supplies of steel from the United States, the situation in that market is of considerable interest. Naturally, production has increased as a result first of the Allied orders before the collapse of France, and since then because of the taking over of a certain number of French commitments by the British Government and general purchases on British account. The June output of pig iron subject to final adjustment totalled 3,805,000 tons, compared with 3,513,685 tons in May. This represented the production of an increased number of blast-furnaces, 181 being in operation in the latter part of the month compared with 172 on June 1st. The output of pig iron for the second quarter of the year amounted to 10,455,502 tons, against 10,613,978 tons in the first quarter. There is still some irregularity between the different producing districts, but in all there are evidences of an improvement in conditions. Of fifty furnaces in the Pittsburg district, thirty-nine are now in operation, whilst a merchant furnace has restarted in Chicago, and a furnace at Boston is to recommence working this month. There is a big demand for steel-making irons, but apart from a little business in low-phosphoric and Bessemer iron the export trade is quiet. It is reported that 50,000 tons of iron is already at seaboard as a result of cancelled contracts. The scrap market has become quieter and the general quotation seems to be 19 dollars to 19·50 dollars d/d steel works sidings. 60,000 tons of scrap purchased by Italy before the declaration of war is reported to be available against offers. Several cargoes are being shipped to Japan. Under the National Defence Act export licences are required for the shipment of twenty-six products, including aircraft parts, equipment, and accessories, armour plate, bulletproof glass, optically clear plastics, aircraft instruments, metal working machinery for melting or casting metal, metal for melting, casting, or pressing.

The Pig Iron Market

The production of pig iron is understood to have increased considerably during recent weeks ; but even so, the demand has also broadened so that the situation cannot be described as any easier than at the beginning of June. Most of the makers are concentrating upon the output of basic iron for the steel works. An assured supply of this description is essential, and whilst British plants have been pressed to the utmost there have also been considerable importations into this country, and the position now is not unsatisfactory. No statistics are available, but when publication is again resumed it will probably be found that outputs during recent weeks have been higher than could have been expected in normal times. The tendency of the demand for hematite iron to increase is one of the noticeable features of the market, and if it were not for the supervision of the Control it is likely that the situation would be distinctly uncomfortable. It is expected that steps will be taken to enlarge the production of this class of iron shortly. The quotation for No. 1 quality is 131s. d/d Scotland, North-East Coast, and West Coast of England, up to 142s. 6d. d/d Birmingham. The situation in the foundry market is somewhat irregular. There is a definite stringency in the low-phosphoric pig iron department, and it is difficult to satisfy fully the requirements of consumers. For this the steadily broadening demand from the engineering foundries for low-phosphoric iron and hematite grades is largely responsible. There is no actual shortage, but some consumers have endeavoured to supplement their supplies by the purchase of hematite. The supplies of high-phosphoric foundry iron appear sufficient to meet the requirements of consumers, which are on a lower scale than might be expected as a result of the quiet demand from the light castings industry. Lately there has been a noticeable increase in the demand for forge grades.

The Midlands and South Wales

Neither the heavy steel works nor the re-rollers find any relaxation in the pressure their customers are exerting to obtain supplies of all descriptions of steel. Deliveries, however, to a great extent have been taken out of the hands of the management and are ordered by the Control. Definite instructions are given as to the priority of the work in hand and its distribution, and in this way the steel materials produced are used to the best advantage in the national interest. Orders for steel for work of a non-essential character receive little attention, and even material for export receives secondary consideration. The output of joists, bars and sections is maintained at a high level, but even so it is difficult fully to meet the demand, and there have been reports of some delays in deliveries. An enormous amount of work is being undertaken by the constructional engineers all over the country, and their requirements show no signs of diminishing. The call for small bars, small sections and strip is insistent, and although output is well maintained it passes at once into consumption. All the works are fully booked for a long time and so far have been receiving adequate supplies of semis in spite of the loss of Belgium and Luxemburg as sources of supply. Considerable importations of American semis are expected in August. The position of the Midland iron works has also improved since the munitions drive started, and most of them now have substantial order books. The demand is particularly strong for small rounds, squares and flats and the works are making big deliveries. The South Wales steel works are booked as far forward as they care to accept orders and, as in other parts of the country, the production is almost entirely on Government account. Even working at full capacity the resources of the works are barely sufficient to meet the heavy demand. The tin-plate trade is quieter than for some time, but the works have orders for over six million boxes on their books and are in no way perturbed by the situation.

Scotland and the North

Normally the annual Fair Holidays would have checked production at the Scottish steel works. This year, however, production continued, excepting in cases where plant had to be overhauled, and where a few consumers ceased operations for a short time to give their workpeople a much-needed rest. Most of the big consumers, such as the engineering works and shipyards, continued operations during the holiday period without any interruption. The position, therefore, has not changed, and the works have to strain every nerve to supply the heavy requirements of the consuming industries. The constructional engineers, in particular, are fully employed, and the demand for joists, bars, and sections is well maintained. This industry has been working at full pressure for many months, but its powers of absorbing manufactured steel seem to be increasing rather than the reverse. Plates of all kinds are heavily in request, and some stringency is noticeable in this section. Not only are the shipyards' requirements abnormal, but there is a steady demand from the locomotive makers, wagon builders, and tank makers. Lately there has been a noticeable increase in the call for armoured plate, shell steel, special steels and alloys. The manufacturers of billets and sheet bars are attaining large outputs, but in spite of this it has been necessary to supplement the home production by considerable imports. In the Lancashire market there is a steady and increasing pressure to obtain supplies. Distribution and production are closely supervised by the Control, and consumers engaged upon war production are adequately provided for. There is a particularly heavy demand for bars, both large and small, as well as for reinforcing concrete material, whilst the request for bright drawn steel bars shows signs of further expansion. On the North-West Coast the works are fully employed almost entirely upon Government orders. Outputs are maintained at a high level, and some success has been attained in the effort to raise the production of native iron ore.

Lead and Spelter

It is probable that there are larger supplies of lead available for commercial purposes than of any other non-ferrous metal. Arrivals are said to be reaching this country freely, and it is understood that a certain number of French contracts for lead were also taken over by the British Government. The situation is thus satisfactory ; not only are those firms engaged upon essential war work fully supplied, but a certain amount of raw material is available for those firms making exportable products. The Control, however, continues to supervise carefully the distribution of the metal, and on the whole the trade is not inclined to grumble, since this is a natural precaution in case of any stringency developing later on. Many firms would like to hold a reserve stock of the metal, but this practice has been frowned upon by the Control since the beginning of the war. It seems likely that greater use in the future will be made of scrap lead, as although adequate supplies are obtainable from Empire sources the question of shipping space is important. . . . The spelter market has developed no fresh feature. There is still a certain amount of stringency in the supplies of metal to firms which are engaged upon what is regarded as non-essential work. Even those firms making goods for export do not find it easy to obtain their full supplies. On the other hand, by far the greater number of consumers are engaged upon war work and are receiving their supplies with regularity. The requisitioning by the Control of copper held on warrant has led to the expectation that a certain amount of spelter similarly held by foreign interests is also likely to be requisitioned. In the United States the market is moderately active and the quotation is held at 6·25c. East St. Louis.

Copper and Tin

The weakness in the American copper market which has been noticeable recently continues, and although the big producers continue to maintain their official rate for domestic sales at 11·50c. the Customs smelters are prepared to accept 10·50c., and sales have been reported at 10·45c. American domestic consumers are inclined to adopt a policy of watching and waiting, and since there is no support from the export market the tendency is for quotations to recede. There has been little business passing in the export section, and whilst the general price is called 10·10c. f.a.s. it is stated that Japan has purchased 500 tons at 10c. Apart from some inquiry by India there seems to be practically no export business offering. To some extent the presidential election is blamed for the quiet state of the domestic market, and it is suggested that until September at least, when the political outlook becomes clearer, the situation is not likely to change. The market, however, is awaiting the development of buying on account of the American rearmament plans. In Great Britain the position is unchanged and consumers are obtaining their full requirements of copper. The Non-Ferrous Metal Control recently requisitioned 2000 tons of copper held on London Metal Exchange warrants by foreign interests. Payment is to be made at the rate of £54 per ton, based on London Metal Exchange standard contract terms. . . . The tin market has been more active than for some time, and prices have shown a tendency to advance. It is not expected, however, that prices can move upwards to any great extent as the United States Government is now willing to take all surplus tin at 50c. Whilst this in practice is an assurance that the price will not go below 50c., it has, at the same time, a tendency to become the maximum price. The stocks in the London Metal Exchange official warehouses have been considerably reduced recently, and this has aroused some comment. It is expected, however, that arrivals of tin due shortly will be placed on warrant. American buying has been rather erratic.

Notes and Memoranda

Rail and Road

L.N.E.R. Retirement.—Mr. C. J. Selway, C.B.E., is shortly retiring from the position of Passenger Manager, Southern Area, London and North-Eastern Railway. He has been in the company's service since 1892, and was appointed to his present position in 1923.

Harwich-Shotley Motor Boat Service.—The London and North-Eastern Railway Company announces that the Harwich-Shotley motor boat service will be discontinued from August 6th. The Harwich-Felixstowe service will be maintained by one boat running an hourly service.

Aluminium Scrap from Booking Halls.—A large number of aluminium frames, which were supplied to booking halls on the L.N.E.R. for the purpose of displaying excursion and cheap travel handbills, have now been withdrawn and have made available half a ton of aluminium for scrap.

G.W.R. Appointments.—Consequent upon the retirement of Mr. E. W. Gould as manager of the Great Western Railway Company's docks at Milbay, Plymouth, Mr. R. Dixon, formerly of Cardiff, is acting as manager, and the duties of chief clerk are being discharged by Mr. W. A. C. Morris, who has gone there from Cardiff to succeed Mr. Ivor Thomas. The last-named has been transferred to a South Wales port.

An L.N.E.R. Appointment.—It is announced that Mr. A. L. Gibson, the Continental traffic manager of the London and North-Eastern Railway Company, has been appointed to the additional post of acting passenger manager, Southern Area, succeeding Mr. C. J. Selway, who is retiring. Mr. Gibson is well known both in this country and abroad, and was one of the permanent delegates of the British railway companies to the annual conference of the International Union of Railways.

Producer Gas Vehicle Conversions.—In reply to a question by Sir Arnold Gridley, put to the Minister of Transport recently, as to the number of commercial vehicles converted from petrol to gas operation and the increase in number of electrical battery operated vehicles, the Minister of Transport, Sir John Reith, stated that a total of 605 goods and public service vehicles had been converted from petrol to gas operation between September 30th, 1939, and June 30th, 1940. The increase in licensed electric battery goods vehicles between August 31st, 1939, and May 31st, 1940, was 578.

L.P.T.B. Officers Lent to the Government.—The London Passenger Transport Board announces that it has lent three of its principal officers to the Government. They are Mr. A. A. M. Durrant, Chief Engineer (Buses and Coaches), who has been appointed Director of Tank Design, Ministry of Supply; Mr. W. S. Graff Baker, Chief Mechanical Engineer (Railways), who has been appointed Director of Tank Production, Ministry of Supply; and Mr. M. J. H. Bruce, Works Engineer (Chiswick), who has been appointed Mechanical Engineering Adviser to the Quartermaster-General, War Office.

New York Express Highway Opened.—A 33-mile new arterial highway was recently opened in New York, only about nineteen months after construction was started. The new road is known as the Belt Parkway and extends from Owl's Head Park in Brooklyn to the Bronx-Whitestone bridge across the East River in Northern Queens. There are four traffic lanes for the greater part of its length and six lanes on the remainder. Forty-seven bridges were built to eliminate cross roads, five to avoid railway crossings and six to carry the road over waterways. There is also a viaduct 2740ft. long at Coney Island. The total cost was nearly 30 million dollars.

Ministry of Transport Appointments.—The Minister of Transport has appointed Mr. R. H. Hill to be Deputy Secretary to the Ministry in succession to Sir Alfred Robinson, who retired on August 1st. Mr. Gilbert Szlumper has been appointed to succeed Mr. Hill as Railway Control Officer at the Ministry. Mr. Szlumper relinquished the post of General Manager of the Southern Railway at the outbreak of war to become the Director-General of Transportation and Movements at the War Office. Sir Alfred Robinson is for the time being continuing to assist the Ministry in connection with certain general questions arising out of war conditions.

Steam Wagons in War Time.—In the current number of *Highways and Bridges*, Mr. Hugh Miller advocates the production and use of steam wagons, by reason of the need for using alternatives to imported fuels. He states that the steam wagon is a vehicle of proved efficiency, and that it has not been outclassed, but has been legislated off the roads. Its manufacture has practically ceased for the past ten years because of excessive taxation and axle weight restrictions. He maintains that if steam vehicles were permitted to supply the need for heavy haulage, the importation of fuel problem would be sufficiently relieved so as to enable a more liberal ration of petrol to be given to lighter vehicles engaged in essential services.

Air and Water

Auckland Harbour Mined.—It was announced by the New Zealand Marine Department on Tuesday, July 30th, that mines have been laid in the northern approaches to Auckland harbour. Details of the area affected have been announced for the guidance of shipping.

Mercantile Losses Due to Enemy Action.—During the week ended Sunday, July 21st, inclusive, the total British tonnage lost was 37,577, comprising eleven merchant ships. One Allied and six neutral vessels of tonnage 2088 and 10,192 were also lost by enemy action during the period named. The total tonnage loss is slightly below the weekly average for the forty-six weeks and rather less than one-fourth of the highest weekly total loss. A computation of the total enemy losses up to Sunday, July 28th, shows that the German losses amount approximately to 908,000 tons and Italian losses to 254,000, giving a grand total of about 1,162,000 tons. In addition to these losses about 22,000 tons of shipping, formerly neutral, but now under enemy control, have been sunk.

Aluminium Transport by Seaplane.—By purchasing the privately owned seaplane "Guba," belonging to the American explorer, Mr. Richard Archbold, the Ministry of Aircraft Production will be able to transport 3½-ton cargoes of aluminium from the United States to Great Britain twice a week. The seaplane is to be operated by a crew of four, including the American airman, Clyde Pangborn.

Admiralty Camera Ban.—The Admiralty has made an Order restricting photography in home waters. By this Order passengers and crews in any ship travelling between Great Britain and a port overseas, including Eire, Northern Ireland, or the Isle of Man, or *vice versa*, have to hand their cameras to the master, who will retain them so long as the ship is in British waters. In all other ships in United Kingdom waters, no person may carry a camera or take any photograph without a written permit issued by a naval authority. The same restriction is also applied to the carrying of cameras or photography in any public place in the Orkneys and Shetland Islands.

London Canal Abandoned.—Under a warrant of the Ministry of Transport, part of the Grand Union Canal running through London is to be abandoned. The Order releases the company from liability to maintain the portion of the canal in the borough of St. Pancras, known as the Cumberland Arm and Basin, extending from the canal cut to the main Regent's Park section. The 340ft. stretch from St. Mark's bridge in the park is, however, excepted. The company has stated that the abandonment was necessary in order to close a dock which had become redundant, and that the action does not affect the main canal. The Grand Union Canal system comprises 282 miles of inland waterways linking London and Birmingham, with branches in the northern home counties and Midlands.

Immobilisation of Vessels on Inland Waters.—It is now necessary to take steps to prevent vessels on inland waters being used by an invader; the Ministry of Home Security has issued an Order to this effect to owners of motor and sailing craft as well as of rowing boats, punts and canoes. Vessels in these categories may not be left unattended either afloat in, or on land near, a canal, navigable river, lake, or broad in England, Wales, and Scotland unless they have been made incapable of use. Parts of the mechanism of steam or motor vessels must be removed, and such articles as sails, masts, oars and rowlocks must be removed from sailing or rowing boats. A similar Order was made by the Admiralty recently in connection with vessels in coastal waters in certain areas, and methods of immobilisation were referred to in a Journal note in our issue of July 19th.

Aircraft from America.—Lord Beaverbook, Minister for Aircraft Production, stated in a broadcast last week that a message received from the agent of the Ministry in the United States and Canada was to the effect that the Secretary of the Treasury in the United States Government would approve plans to put into immediate production aeroplanes for our account up to a total output of 3000 a month. Those plans would be developed without delay, and the output would be in addition to our present American programme. Since the formation of the Ministry, 12,115 aero-engines had been bought in America. Most of the aircraft frames were to be built in Britain, and the American engines were to be fitted here. There had been a record British aircraft production the previous week, he said, and the output of engines and aircraft for July had been more than double the output of last July.

British Naval Losses.—Naval losses in the week under review include the destroyer H.M.S. "Wren," a ship of the modified "W" type, which was laid down by Yarrow and Co., Ltd., in August, 1918, and was completed at Pembroke Dockyard in February, 1923. She had a displacement of 1120 tons, with a length of 312ft. overall, a beam of 29ft. 6in. and a mean loaded draught of 10ft. 10in. Her armament comprised four 4·7in. guns, director controlled, two pompoms, one machine gun, and four Lewis guns. Six 21in. torpedo tubes arranged in two triple mountings were carried. The propelling machinery consisted of a twin-screw arrangement of all-geared Brown-Curtis turbines taking steam from Yarrow oil-fired boilers. The total horsepower of the turbines was about 27,000 S.H.P., corresponding to a trial speed of 34 knots under light-load trial conditions, and about 31 knots under deep-load conditions. Other losses reported include the H.M. trawlers "Fleming," "Staunton," "Kingston Galena" and "Rodino," also the H.M. auxiliary patrol yacht "Gulzar." All these ships have been lost as a result of enemy air attack, except the "Staunton," which was sunk by an enemy mine.

Stratosphere Research.—A steel "strato-chamber" has been designed and made by the research department of the Boeing Aircraft Company of Seattle. The chamber, which is complete with air locks, superchargers, vacuum pumps, control valves, and refrigeration, re-creates on the ground the conditions of supercharged flight up to altitudes of 40,000ft. and beyond. The stratosphere begins at approximately 36,000ft., where the atmospheric pressure is less than one-fourth the pressure at sea level. In the test chamber engineers can "fly" in a few minutes' time to any desired altitude, either with comfortable supercharged air conditions or with oxygen masks and no supercharging. Within the sealed walls of this chamber are combined both the rarefied, frigid outside air of the stratosphere, and in another compartment the warmed, normal air of a modern supercharged aeroplane cabin. The strato-chamber consists of a 3-ton tank, 12ft. long by 5½ft. in diameter, fitted with pressure-tight doors at each end and divided into two compartments, which are interconnected. One represents the cabin of the aeroplane, the other the outside air. There is room for several engineer observers to occupy the sealed chamber at one time. Controls are fitted both on the inside and the outside.

Miscellanea

Recovering Aluminium Cable.—The Manchester Corporation Electricity Committee has decided to recover 2600 yards of aluminium conductor underground cable which was laid during the last war at a time of serious copper shortage. Because of changes in the distributive system the cable would have been put out of use in a few months' time, but the Committee's decision to recover it without delay will provide between 6 and 7 tons of drawn aluminium.

Emergency British Standard Specifications.—To meet the requirements of war-time conditions, the British Standards Institution is issuing War Emergency Standards or Revisions of a number of its specifications. These emergency standards are being published in distinctive form, printed on yellow paper. They are intended only for home market use, and will be valid only during the period of hostilities. A number of emergency standards has already been issued, and others are under preparation.

City of Wellington Public Libraries.—The City Librarian of Wellington, New Zealand, informs us that the Commercial and Technical Department possesses an extensive collection of trade catalogues which is accessible to the public. The object of the collection is to bring together the buyers and sellers of goods and manufactures. He asks us to state that the library would be pleased to receive copies of trade catalogues as they are issued. They should be addressed to the City Librarian, Central Library, P.O. Box 1529, Wellington, C.1, New Zealand, and their receipt will be acknowledged. Packets should be marked "Printed Matter Only" and forwarded as second-class mail.

Exterior Lighting in Air Raids.—The Ministry of Home Security announces that it has been decided, in connection with the present air raid warning system, to make special provision for dealing with certain forms of permitted exterior lighting, including headlamps on motor vehicles and lighting allowed to industrial establishments engaged in essential production. At certain times it may be necessary to require such lighting to be extinguished, although air raid sirens have not been sounded. Members of the public, observing such lighting being extinguished, need not take cover until the warning is sounded. Motor drivers will be warned by the police when to extinguish headlamps. They will be permitted to proceed, but headlamps must be extinguished until they are informed that they may be relighted.

The Steel Control.—Mr. Ralph Alsop has relinquished his post of Deputy Controller of Steel Supplies under the Ministry of Supply to resume his position as general manager of the Consett Iron Company. Since the outbreak of war, when Mr. Alsop was seconded from his company to the Steel Control, he has been largely responsible for the control and distribution of steel supplies, which, after he had overcome the initial difficulties, have worked smoothly and effectively. Mr. Alsop's retirement is the sequel to the retirement of Sir Edward George from the position of general manager of the Consett Iron Company, with which he has been associated for many years. Sir Edward would have retired on October 31st last year, but continued in his post in order to allow Mr. Alsop, who had been appointed to succeed him, to take up his post with the Control. Mr. J. M. Duncanson will succeed Mr. Alsop as Deputy Controller of Steel Supplies.

Sugar Mill Machinery.—The Standards Association of Australia has issued, for public comment, two draft Australian Standards for cane trucks and for fixed-running steel wheels and axles for cane trucks. These specifications were prepared at the request of the Queensland Society of Sugar Cane Technologists, and are the first of a series intended to cover the requirements of the sugar industry. The draft specification for cane trucks, No. N.16, covers materials, dimensions of bodies and buffers, hornplates, wheel gauge, wheel sizes, axles, couplings and hooks, chain, ratchets and marking. That for wheels and axles includes clauses dealing with nominal diameters, materials for wheels and for axles, size, dimensions, weight and gauge of wheels. Schedules dealing with composition, treatment and tests for cast steel and manganese steel wheels and for materials for axles are also included. The two drafts are issued under one cover and copies may be obtained from the headquarters of the Association and from its branch offices in the various States.

CATALOGUES

Mirrlees Bickerton and Day, Ltd., Hazel Grove, near Stockport.—Catalogue No. 19,740, describing "Mirrlees-Imo" rotary screw pump.

Latem Electrical Company, Eastwood Street, Hall Lane, Bradford.—Leaflet dealing with the "Latem" lamp, specially suitable for air raid shelters.

Soag Machine Tools, Ltd., 7, Juxon Street, London, S.E.11.—Folder describing lathes and radials manufactured by the American Tool Works Company.

English Electric Company, Ltd., Queen's House, Kingsway, W.C.2.—Publication W 72, dealing with "Synchronous Induction Motors for Power Factor Correction."

Crossley Brothers, Ltd., Manchester, 11.—Brochure illustrating and describing scavenge pump Diesel marine engines, ranging from 50 to 600 B.H.P.

Broadway Engineering Company, Ltd., Carlisle Road, Hendon, N.W.9.—Leaflets describing the Vernon 11in. shaper pedestal, high-precision milling machine, and vertical milling machine and jig borer.

Westinghouse Brake and Signal Company, Ltd., Pew Hill House, Chippenham, Wilts.—Pamphlet 11 M, on the "Static Phase Converter," and Pamphlet 11 E, on "Metal Rectifier Chargers for Electric Vehicle, Truck and Handbarrow Batteries."